For Editorial Contents see page 411

PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION.

Engineering Library

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY CHAS. COOPER AND J. FOSTER PETREE.

TEMPORARY OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 18 & 20, COMPTON ROAD, HAYES, MIDDLESEX.

VOL. 150—No. 3906. *LONDON: FRIDAY, NOVEMBER* 22, 1940. *Registered at the General Post Office as a Newspaper* PRICE 1s. BY FOREIGN POST 1s. 3d.

S.E.A. RINGS
SYNTHA Packings
EFFICIENCY
RELIABILITY
RONALD TRIST & CO. LTD.,
BATH ROAD, SLOUGH.

INFINITELY BETTER
SPRINGS
SUPER GRADE SPRINGS OF EVERY DESCRIPTION FOR EVERY PURPOSE
On Admiralty, War Office, and Air Ministry Lists. Established 1821.
ROBERT RILEY LTD. 9089
Milkstone Spring Works, Rochdale. Tel. 2572

DYSON TRAILERS
R. A. DYSON & CO., LTD.,
GRAFTON STREET, LIVERPOOL 785
Models to carry from 3 cwts. to 150 tons.

J. & E. HALL
REFRIGERATION
FOR LAND & MARINE PURPOSES
LIFTS AND ESCALATORS
J. & E. HALL LTD., ENGINEERS, DARTFORD, KENT.
Telephone: Dartford 3456.
London Office: 10, ST. SWITHINS LANE, E.C.4.
Telephone: MANSION HOUSE 9811. 1263

WHEEL
KEYS
OF ALL TYPES. LARGE STOCKS.
H. FORDSMITH LTD.,
Hadfield Street Works, Cornbrook,
MANCHESTER, 16.
TRAfford Park 0789. 793

GLASS For Machinery
BUTTERWORTH BROS., LTD., 9753
Newton Heath Glass Works, Manchester.

DANIELS
FOR
PLATENS
STEAM, GAS OR ELECTRIC
T. H. & J. DANIELS LTD.
STROUD, GLOS. Phone: 661/2/3.

LOCOMOTIVES
STEAM OR DIESEL
HUDSWELL CLARKE & Co. LTD.
RAILWAY FOUNDRY, LEEDS
London Office: 46, Victoria St., S.W.1.
Telephone: Victoria 1133 8559

SPENCER - BONECOURT
Patent Waste Heat Boilers
32, Farringdon Street, London, E.C.4. 868

YARROW
& CO. LTD.,
GLASGOW
SHIPBUILDERS
MARINE ENGINEERS 848
LAND AND MARINE BOILER MAKERS

CRADLEY BOILERS
CRADLEY BOILER CO., LTD., 1088
CRADLEY HEATH, STAFFS.

PETER BROTHERHOOD
PETERBOROUGH LTD.
STEAM ENGINES AND TURBINES,
GAS AND OIL ENGINES,
AIR COMPRESSORS,
REFRIGERATING PLANT.
See advertisement, Page 29, Nov. 15 6938

CRANES
GEORGE RUSSELL & CO., LTD.,
Motherwell. 816

BAWN
SHEET METAL WORK.
STEEL PLATE WORK.
Road Tanks. Chemical Plant. Oil Tanks. Air Receivers. Hoppers. Chutes. Ducting, Chimneys, Galv'd Cisterns. Tanks. Cylinders. Guttering. Sinks
W. B. BAWN & CO. LTD.,
Blackhorse Lane, Walthamstow, London, E.17.
Telephone: LARKswood 4411 (3 lines).

Research Engineers, Ltd., Northampton Grove, Canonbury, London, N.1. Design and construction of mechanical and electrical machinery and apparatus. Experimental work of any description. We have also a department for quantity production on completion of experiments. 1071

SPRINGS
of every description for all trades.
Flat and Spiral.
ROBERT MATHER
CARR SPRING WORKS, RAMSBOTTON, Near MANCHESTER.
Telephone: 3119. Established 1884.

"ACTARC"
Electrodes & Welding Plant
ARC MANUFACTURING CO., LTD.,
ACTARC WORKS, LONDON, W.12.

Trepanning machine for tube plates, three 3¼ in. spindles. Admits plates 10 ft. 6 in. by 8 ft. 6 in. Table size, 8 ft. 6 in. by 7 ft. Traverse, 8 ft. CII. seat for motor. Makers, Campbells & Hunter.—Apply Danks of Netherton, Ltd., Netherton, Dudley, Worcs. J 292

SPECIAL MACHINES
MADE TO ORDER
Parts and repairs
Erection of Plant
Millwrights work 952
THOMAS HUNT & SONS
Bridge Road West, BATTERSEA, S.W.11.

HYDROJET
BABCOCK & WILCOX

RAPIER
WALKING DRAGLINES
RANSOMES & RAPIER LTD.
Ipswich England 1016
Builders of Europe's Largest
EXCAVATORS

BAXTERS
"PATENTED KNAPPING MOTION"
STONEBREAKERS
and ALLIED SPECIALITIES 756
W. H. BAXTER, Ltd., Leeds, 12.

MUREX
Electrodes
1107
MUREX WELDING PROCESSES LTD.,
HERTFORD RD., WALTHAM CROSS, HERTS.

MACROME treated
TOOLS do more
work in less time
MACROME
LIMITED
Z Dept., HAY MILLS, B'HAM, ENG
Phone: VIC. 1283-4.

GEARING
BARRY, HENRY & COOK, LTD. 789

MACHINE WORK.
TURNING, FACING, GRINDING, etc.
PLANING UP TO 12ft. 0in. by 4ft. 0in. by 4ft. 0in.
WELDING AND CONSTRUCTIONAL WORK.
EXPERIMENTAL WORK.
ROSSER & RUSSELL, LTD.,
QUEEN'S WHARF, HAMMERSMITH, W.6.
'Phone: RIV. 4416. 9211

Alfred Herbert Ltd., Coventry
PAY BEST PRICES for SECONDHAND MACHINE TOOLS in good condition, by first-class makers.—Write, wire, or phone, and our representative will call. 'Phone 88781 Coventry. Telegrams LATHE, Coventry. W 205

ASH & DUST
LTD., 34, FARRINGDON

For Machine Cut Gears of highest quality — TRY
MOSS GEARS
THE MOSS GEAR CO., LTD.,
Crown Works, Tyburn,
Birmingham 8041

On Active Service
COOPER
SPLIT
ROLLER BEARINGS
KING'S LYNN 1158 NORFOLK

SAND FILTERS
JOHN THOMPSON
(KENNICOTT WATER SOFTENERS) LTD.,
WOLVERHAMPTON.
Estd. over 40 Years. 1203

PISTON RINGS
HARRY LANCASTER & CO. LTD.
1/3, BRIXTON ROAD, LONDON, S.W.9.

HOWELLS ELECTRIC MOTORS

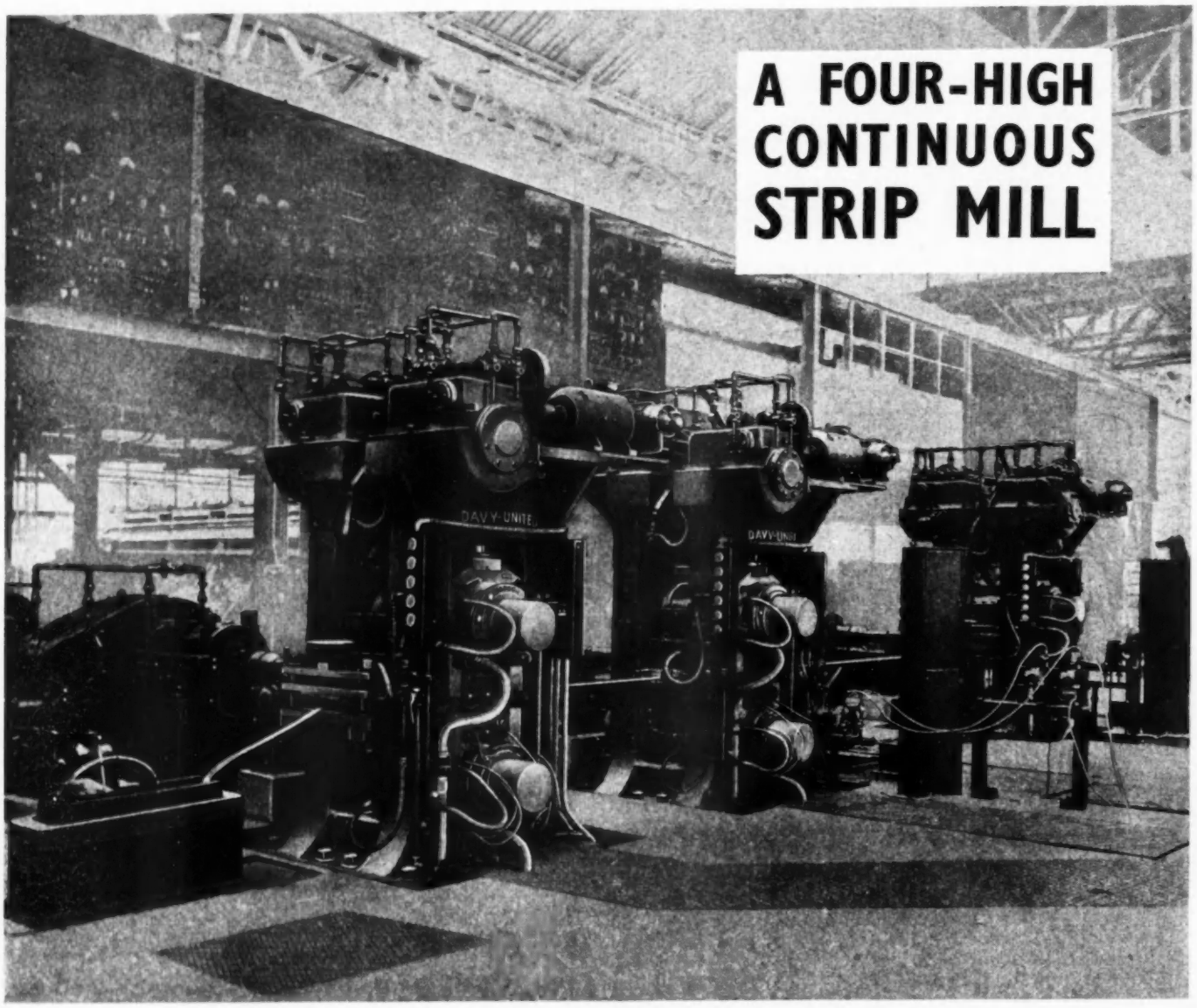
DREDGERS
OF ALL TYPES
FERGUSON BROS. (Port-Glasgow) LTD.
PORT-GLASGOW. 1078

FRICTION CLUTCHES
All Types. Satisfaction Guaranteed.
W. R. ANDERTON & CO.,
Clutch Specialists,
CASTLETON, ROCHDALE 506

ALLDAYS & ONIONS
685 BIRMINGHAM LTD.
BLOWERS ROOTS AND ROTARY

"The machine with a BRAIN"
SCIAKY
SPOT WELDERS
SLOUGH —— 22342

SLUICING 866
STREET, LONDON, E.C.4



DAVY-UNITED

The illustration shows a modern plant for the production of narrow and medium width strip. The mills are of the most efficient design and ensure high rate of production and extreme accuracy of product.
As designers and builders of Rolling Mill Machinery for more than 60 years, we are able to supply plant exactly suitable for every duty.

1113

DAVY AND UNITED ENGINEERING COMPANY LIMITED - SHEFFIELD

SOIL EROSION BY WIND ACTION.

(*Concluded from page* 365.)

Almost any type of tillage implement may be used to roughen the surface of the soil in order to trap drifting sand and check erosion. The best results, however, are obtained if deep furrows are formed and the land is left in a cloddy condition. A good example of the desirable type of surface is shown in Fig. 19, on Plate XXV, *ante*. On many soils, the ordinary type of cultivator is quite effective, but the land is left in a rougher state and better results are obtained if some of the cutters are removed and the remaining ones set at from 22 in. to 42 in. centres. This class of implement is cheap to operate and covers the ground rapidly. The furrows formed in this way, however, are relatively shallow and the use of a lister, a type of deep plough, is to be recommended. An example of an implement of this type in operation is shown in Fig. 20, on Plate XXVIII. The deeply-furrowed surface left after the passage of the machine is well shown at the left-hand side of the illustration. The furrows being formed are about 1 ft. deep. The work is being carried out in Beadle County, South Dakota. After the preparation of the land in the way shown, rye was planted broadcast. A further example of the breaking up of the surface by means of a lister is illustrated in Fig. 21, which refers to a farm in the State of Kansas. The work being carried out in this case is of an experimental nature. The man standing on the back of the implement, by means of levers, raises the various ploughs in turn for brief periods. The result of this is that small cross-dams are formed in the furrows at more or less regular intervals. The purpose of these is to increase absorption by checking the run-off.

On land which is too hard and dry to work with a lister, some farmers have been able to break up the surface by means of an ordinary disc plough with most of the discs removed. For really hard land, however, the chisel, or tine, cultivator is probably the most effective implement. This brings clods to the surface even in difficult soils. An example of work being carried out with an implement of this kind on a farm in Kansas is shown in Fig. 22, on Plate XXVIII. In extreme cases of hard, rocky and severely eroded land, road scarifiers have been used to break up the surface. An example of this practice is shown in Fig. 23, which relates to Dallam County in Texas. The photograph from which the figure was prepared was taken on October 21, 1937. The breaking up of the land by the scarifiers was followed by treatment with a lister in order to form deep furrows. The field was planted with clover in the spring of 1938 and was subsequently returned to native grass.

Land essentially unsuitable for carrying cereal crops, but which, none the less, has been ploughed up for that purpose, with consequent serious erosion, may be brought back to pasture by planting grasses after treatment of the surface. In this way, wind erosion may be permanently checked. Success, however, demands care and consideration of the local conditions. Many weedy grasses have characteristics of high economic value from the point of view of holding the soil against the force of high winds, but none of them is suitable for all soils and situations. The use of some types, moreover, involves costs which local circumstances may render prohibitive. Among those which are satisfactory from an economic point of view, careful selection is necessary. A grass which will thrive on sandy soil may fail on heavy, and that which will grow on gentle slopes may prove unsuitable on steeper lands. Again, grasses which will cover adequately the ground on south slopes may not survive on land inclined to the north. Some require full sun and others are tolerant of shade, and a grass which is excellent for controlling erosion on a stream bank may fail on arid lands.

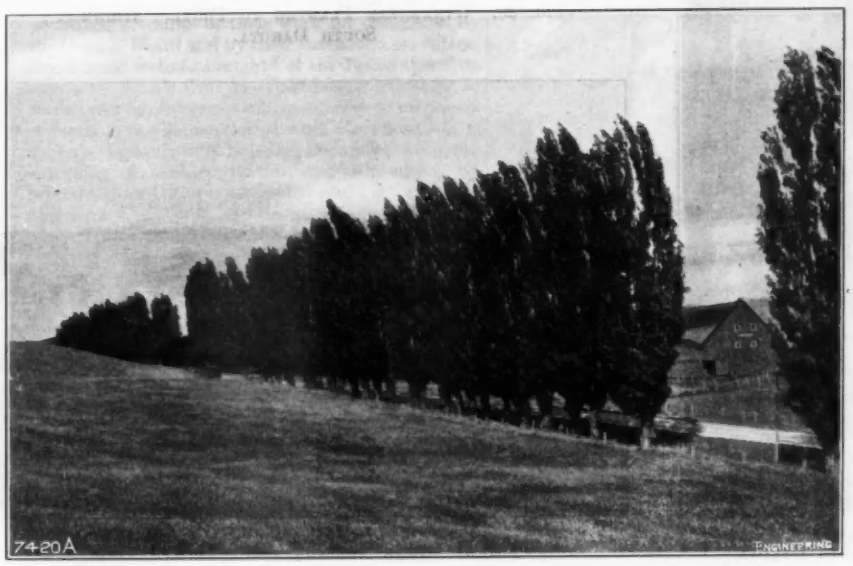


Fig. 28. Windbreak Formed by Lombardy Poplars; Washington.

Consideration of the study which has been made of the characteristics of the various types of grass is a botanical matter, lying outside the scope of these columns, but some reference may be made to the methods of planting employed. The stoloniferous, or sod-forming, grasses, which are extensively used in this reclamation work, call for special arrangements when planted on a large scale. A method which has been used at Waldron, in Arkansas, is illustrated in Fig. 24, on Plate XXVIII. Blocks of freshly-cut sod are carried on the deck of a horse-drawn wagon having metal spouts, about 8 in. in diameter, fitted on each side in line with the wheels. The spouts are provided with conical funnels at the top ends, and men, sitting on the wagon, feed the pieces of sod into these as the vehicle travels forward. The sod is consolidated and pressed into the ground as the rear wheels of the wagon pass over it. An equipment of this kind can sod several acres of pasturage in a day. The method has been most successful when the work has been carried out in the early spring, just before the setting in of the growing period.

The apparently obvious method of covering these prepared areas by seeding presents some difficulty. The seeds of the native United States grasses which are available for this reclamation work are of a light and fluffy type and cannot be fed in an even stream through the ordinary type of seed drill. They also require a well-packed bed and should not be planted at a greater depth than from ½ in. to 1 in. In the past few years various attempts have been made to develop special drills which will handle the seeds of these grasses and a measure of success has been achieved, but such implements are hardly yet available commercially. Work has also been done on the matter by the Nursery Section of the Soil Conservation Service, which, in the winter 1938-39, developed a hand-operated seeder. This was improvised from an ordinary crank-operated seed duster by adding an extension tube and spreader. The implement may be used for the distribution of seeds on contours even on windy days. In some parts of the prairie regions of the United States, a lister device has been developed. This embodies the type of seed box used on cotton plantations and is fitted with a shoe, to control the depth of planting, and a packer wheel. It has had some success and has the advantage that the soil is left ridged after being seeded. This is an important factor in the arid regions of the great plains of the middle-western part of the country.

Another method which is available for protecting the surface of the land against the destructive effects of high winds is the planting of shelter belts of trees and bushes. It is not always an easy matter, however, to establish trees in some of the areas which require protection. The type of wind erosion with which we have been dealing is prevalent in parts of Canada, as well as in the United States, and Sir Daniel Hall has stated that difficulties of this kind have been met in the northern parts of Saskatchewan and Alberta, where an extreme range of climate is met with. Suitable species of trees which can be induced to thrive have, none the less, been found.

Two examples of windbreaks formed by Lombardy poplars and situated, respectively, in Oregon and Washington, in the north-west corner of the United States, are illustrated in Fig. 25, on Plate XXVIII, and in Fig. 28, on this page. The Oregon windbreak, which is situated in Gilliam County, was planted to stop the drifting of the sandy soils which are typical of the alluvial flats adjoining the Columbia River. Persistent strong winds in this region cause a considerable amount of erosion and very active drifting. Windbreaks of the type illustrated, and usually consisting of a single row of poplars closely planted, are set at frequent intervals at right angles to the direction of the prevailing wind. Actually, they have proved only partially effective, as they do not retain their lower branches. The windbreak could be improved by adding a row of Russian olives or caragana, a hardy tree allied to laburnum, in order to provide more cover near the ground. The Lombardy poplar windbreak, shown in Fig. 28, is of the same type as that shown in Fig. 25. It is situated four miles south of Rosalia, Washington, and the trees are approximately twenty years old.

A more effective type of windbreak is illustrated in Figs. 26 and 27, on Plate XXVIII, both of which refer to the same farm in Burt County, Nebraska. The trees have been planted for the protection of a 20-acre field which they completely enclose. On each side of the plot there is a row of poplars, with a parallel row of evergreens in front of it. Nebraska is a state of only moderate rainfall, some 20 in. a year, and the shelter given by these trees is of great value in preventing the blowing away of the snow in the winter, so that the moisture is conserved. It is stated that the development of these windbreaks had doubled the value of the farm. A view showing the inside of a 22-year old shelter belt in Beadle County, South Dakota, is reproduced in Fig. 29, on page 402. These trees were grown from seed and thinned out to 3 ft. or 4 ft. apart, with a spacing of 5 ft. between the rows. The boles of the trees in this illustration are now from 3 in. to 5 in. in diameter.

Many of these shelter belts have been planted by individual farmers for the protection of their property, but various Government agencies have also co-operated in the work. An example of this is furnished by Fig. 30, which incidentally shows a windbreak in its early stages. This was planted by the State Highway Department of South Dakota. These windbreaks, of which there are a large number, are approximately 300 ft. long and 25 ft. wide. They are located on the north side of the highway they protect and are placed some 25 yards back

SOIL EROSION BY WIND ACTION.

FIG. 29. TWENTY-YEAR OLD TREE BELT; SOUTH DAKOTA.

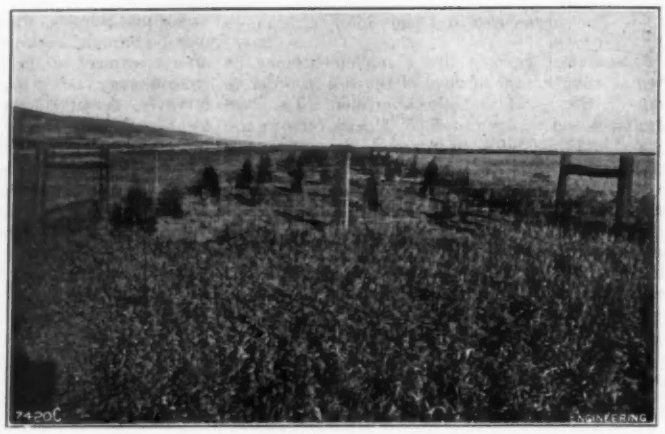


FIG. 30. WINDBREAK PLANTED TO PROTECT HIGHWAY; SOUTH DAKOTA.

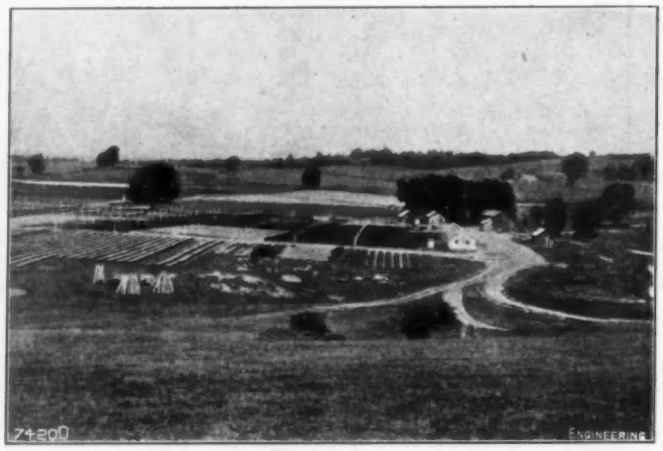


FIG. 31. TREE NURSERY AT ZANESVILLE, OHIO.

in the neighbouring fields. They consist of juniper and Russian olive. The plantations are spaced about six to a mile and are situated on knolls and bottom lands. The main Government agency which is concerned in this protection work is naturally the Soil Conservation Service of the United States Department of Agriculture. The Soil Erosion Service, as it was first called, was set up by the Department of the Interior in 1933, largely for the purpose of finding occupation for unemployed labour. It was transferred to the Department of Agriculture in 1935. The major part of its work is concerned with the reclamation of land which has been eroded by the action of water, or the conservation of that which is threatened, as this is the most serious and widespread source of destruction. This work was dealt with in detail in the series of articles which we published last year, and to which reference has already been made. The Service, however, co-operates in the work rendered necessary by wind erosion, and is in close touch with what is being done. Actually, the whole of the photographs from which the illustrations appearing in this article were prepared were kindly furnished by the Service.

An example of the type of assistance being rendered in carrying out work which cannot well be done by individuals is furnished by the ten forest farms which have been set up in conjunction with the Forest Service. These are located in selected positions in areas subjected to erosion, and represent wide differences in soil and climate. One aspect of the work done is the determination of the most suitable tree species for various areas. A view of the nursery established at Zanesville, in Ohio, is given in Fig. 31, on this page.

LITERATURE.

Production Engineering: Jig and Tool Design. By E. J. H. JONES. London: George Newnes Limited. [Price 12*s.* 6*d.* net.]

WHILE various engineering institutions are willing to suggest the titles of technical books which may be studied by candidates preparing for their entrance examinations, it is unusual for such a society to recommend a book by means of a specific notice inserted in the book itself. That this distinction should have been conferred by the Institution of Production Engineers upon this book by the works manager of the Associated Equipment Company is a direct invitation to subject it to a more searching criticism than it might have encountered otherwise; for few serious readers of technical or other works welcome attempts to anticipate their own judgments. It may be said at once, therefore, that the recommendation is fully deserved in this instance, whatever doubts may be felt regarding the general policy of adding the functions of "book clubs" to those commonly associated with technical institutions. In his capacity of works manager of the Associated Equipment Company, the author has had an extensive experience of jig and tool work in conjunction with the use of modern machine tools; in addition, he has been fortunate in securing the collaboration of his firm in the illustration of the book.

"Jigs and tools," the author states, "are taking the place of the skilled man in the production factory," and this is one of the few of his observations to which exception can be taken, for if there is one thing more than another that the book brings out, it is the importance of the skilled man in designing and making the jigs and fixtures upon which modern quantity production depends. This is especially true in the case of the larger fixtures, in which air and fluid operation is employed to reduce the time occupied in loading and in removing the work. The scope of the book is comprehensive. The general principles are briefly discussed in the opening chapters, some attention being given to fits and tolerances, gauges and cutting-tool materials, but the greater part of the book is devoted to the various devices covered by the title. No attempt is made to deal with press tools, which the author rightly regards as a special study; but broaching is considered fairly exhaustively, as he is of the opinion that this method of machining is likely to be employed even more extensively in the future than it is at present. The book is lavishly illustrated; and, although the quality of the drawings, as such, is somewhat unequal, this is obviously due to the fact that they are reproduced from actual shop designs, and their practical character is likely to be accepted as more than sufficient compensation.

THE JUNIOR INSTITUTION OF ENGINEERS.—The Council of the Junior Institution of Engineers have made a number of awards in respect of papers and lectures delivered during the 1939-40 session. These include the Institution Gold Medal to Mr. Robert Lowe, for his paper, "Gas Producers for Transport Purposes"; the Institution Silver Medal to Mr. S. J. Clifton, for his paper "Power-Plant Control"; and the Tookey Award to Mr. K. W. Willans, for his paper, "The Revival of the Gas Producer." In addition, the Past-Secretary Dunn Medal has been awarded to Mr. R. P. Mears; the Midland Local Section Silver Medal to Mr. W. M. Barratt; and the Sheffield Section Silver Medal to Mr. S. A. Rains.

IRRIGATION RESEARCH IN INDIA.

To everyone with even the most superficial knowledge of the topography and climatic conditions of India the possibilities of artificial irrigation in advancing that country's economic welfare and development are so obvious as to call for no comment; except, perhaps, the remark that practical irrigation along scientific lines has been pursued in India with increasing success for a number of years. It is not widely realised, however, that a considerable volume of experimental research is undertaken in connection with such work, concerned both with the fundamental hydrodynamics common to irrigation in general as a branch of hydraulics, and with specific problems encountered in the design or maintenance of public works. These investigations are carried out, under the Central Board of Irrigation, by five research stations. In the main, the work of all these stations is similar, though differing in respect of problems arising from local conditions and from the presence and effects of large public works in the respective neighbourhoods. Under the existing organisation, all the stations contribute periodical accounts of their work for discussion by the Central Board and by their Research Committee. The annual technical report* of the Board therefore covers the whole field of experimental irrigation in India, and is of corresponding interest to engineers engaged in the same class of work elsewhere. It is a comprehensive, fully indexed, document, arranged according to subject-matter and illustrated by reproductions of photographs and several line diagrams.

Although the latest report deals specifically with the results recorded during 1938 and 1939, the majority of the researches concerned are of the long-term type and in relatively few examples are final conclusions possible. In certain cases, indeed, the indications of experiments in progress are of a negative character, pointing to the importance, on the one hand, of co-ordination among the various research bodies in different States, and, on the other, of knowledge and experience of field conditions on the part of the Irrigation Board's scientific staff. Similar knowledge of, and co-operation with, other Public Works Departments are equally desirable, and are appropriately fostered by the Irrigation Board, since the scientific activities mentioned in the report extend in many directions beyond the strict line of demarcation implied by the term irrigation, interacting, for example, with those of the railway, road and water-supply undertakings. Nevertheless, the investigations in progress are predominantly concerned with the provision, control and distribution of water. Some attention, certainly, is being paid to the relations between water and the types and fertility of crops, but no systematic study of experimental agriculture is at present included in the Board's research programmes.

In view of the emphasis thus placed on the engineering aspects of irrigation, it is not surprising to find that a good deal of the laboratory work described in the report is devoted to model experiments. The Central Irrigation and Hydrodynamic Research Station at Poona, for example, uses a model of the Indus and the Lloyd Barrage at Sukkur to test various alternative designs of the irrigation system in that area with the object of reducing the present tendency, associated with the curvature of the river bed, for the canals off the right bank to become silted up. Other models are used to forecast the success, or otherwise, of measures proposed for training river channels, while a reproduction of a portion of the Ganges to a horizontal scale of 1/500 has been so successful in indicating the changes in the course of a large alluvial river that it is now considered that such tendencies can be forecast with confidence a year in advance. Another successful model experiment has revealed the cause of the collapse, in the floods of 1937, of one of the wing walls of an aqueduct across the Rajuri Nala. Various alternative forms of wall, in combination with measures intended to reduce the destructive effects of the floodwater by straightening the course of the river upstream, were subsequently examined by small-scale apparatus, enabling a warped wing wall to be recommended for the replacement design.

Not all model tests are as successful as these, however, more especially when the erosion or deposition of soil from banks and channel beds is a critical factor. In one such instance, where the design of a proposed bridge, to carry a line of the Eastern Bengal Railway over the Brahmaputra River, was in question, it was found impossible to reproduce the probable scour around the bridge piers on account of the vertically exaggerated scale of the model. Investigations in the river itself disclosed the unexpected facts that, while scour occurs at the bridge site during a steady flood, the river does not scour, and may actually silt, during a very rapidly rising flood. Another example, where the vertical exaggeration of the model was 2·5, the horizontal scale ratio being 1/17, was concerned with the silting of minor irrigation channels taking off from the Jamras Canal. In this case the model results

Fig. 1.

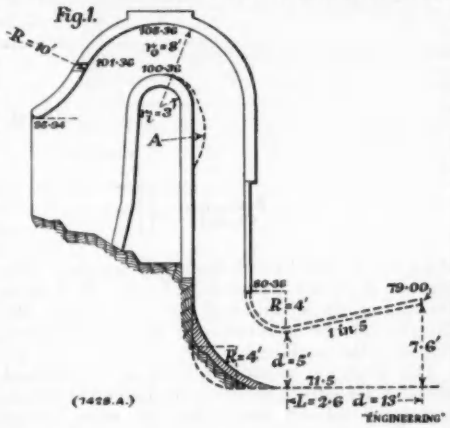
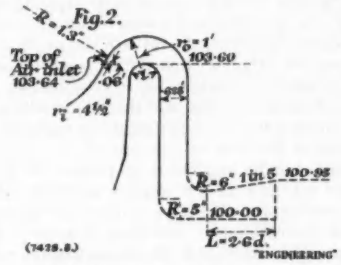


Fig. 2.



were qualitatively correct, but were found, from observation of the behaviour of a recommended design, to be seriously at variance, quantitatively, with those of the full scale. The disparity has been ascribed to false interpretation of the model performance, associated with insufficient knowledge of the proper relationship to be adopted between the horizontal and vertical scales; but opinion upon this question of members of the Research Committee appears to be divided and inconclusive, insufficient evidence being available as yet from experience in India to confirm or refute the correctness of $1/x$ and $1/x^{\frac{3}{2}}$, respectively, for the horizontal and vertical scales to be adopted provisionally for models employing the same grade of sand or sediment as the prototype. The Board's view is that any scales which may be adopted must be verified subsequently in the model—for example, by adjusting wetted surfaces until known flow profiles can be accurately reproduced—and their report emphasises the importance, in the future success of model experiments for solving irrigation and river-training problems, of collecting and analysing the full-scale results of measures adopted as the outcome of model tests. In this connection, it is noteworthy that the time taken for the effects of river-training works and similar structures to become apparent differs widely according to the nature of the bed of the channel, and in certain recorded cases has taken as long as ten or fifteen years.

The same general considerations apply to that class of hydraulic model which aims at predicting the discharge over or through structures, and which finds numerous applications in Indian irrigation research. An instructive example of this type is illustrated by Figs. 1 and 2, herewith, which show, respectively, a siphon spillway at Khadakvasla and an experimental model to a linear scale of 1/8. The capacity of the prototype siphon is 520 cusecs. Without the flared outlet, shown dotted in the diagrams, the discharges of the siphon and the model were dynamically similar for corresponding working heads. The pressures observed at similar points on the inner shells, however, were slightly less than those corresponding to the scale, although approximating closely to them.

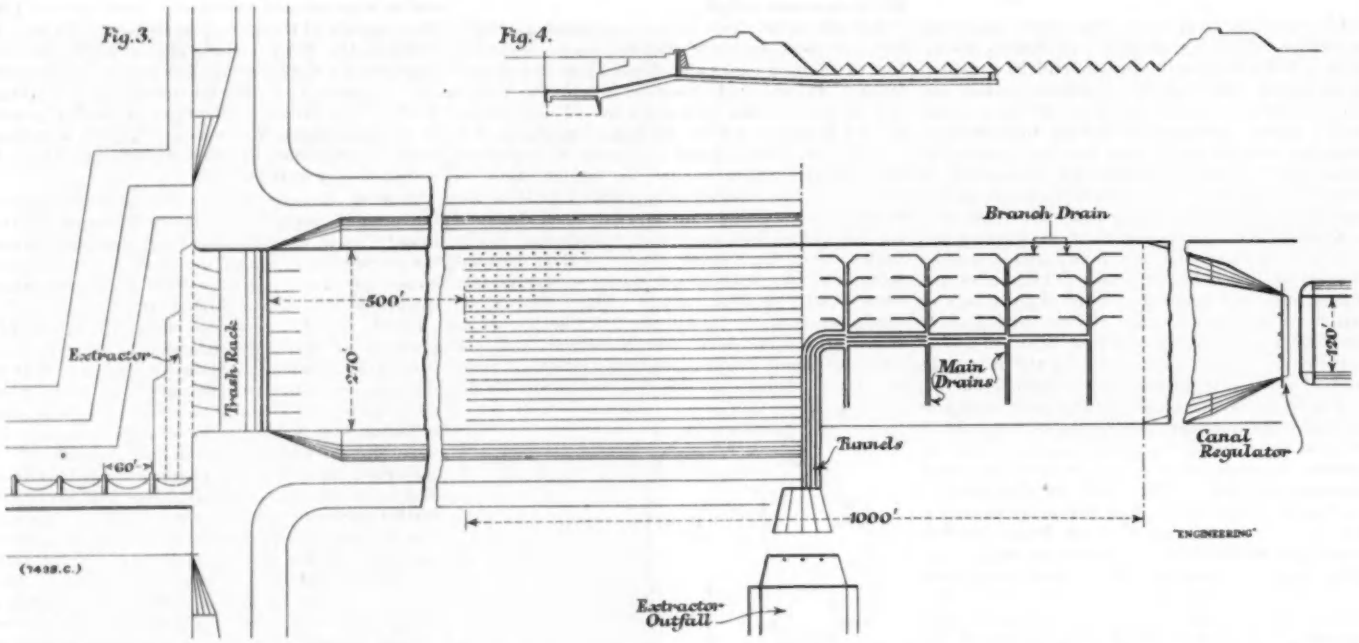
Priming, however, was not dynamically similar, the priming depth being relatively greater in the model than in the full scale, and dependent upon the evacuation of air by the flow of water, which is not similar in the two sizes of siphon under conditions of equal Froude number. Finally, when the flared outlets were added, the full supply discharge of the model increased by 30 per cent., from 2·71 cusecs to 3·54 cusecs; whereas that of the prototype increased by only 3 per cent., from 503 cusecs to 518 cusecs. This disparity was established as being due to cavitation in the full-sized siphon, which occurred, just downstream of the crown-arch, near the region indicated by A in Fig. 1, at the maximum discharge and prevented further increase. The occurrence, and consequent flow restriction, of cavitation is said to be reduced by increasing the radius of curvature of the arch. A remedial measure, perhaps less obvious, that might form the subject of a future investigation, would be to make the siphon continuously convergent to a point well beyond the rear of the inner bend where cavitation is found to take place in the present design.

Other subjects already undergoing experimental study include control sluices in irrigation canal gates, water falls furnished with baffles and deflector vanes, and protective measures against scour below weirs and natural rapids. In all these cases, close attention is being given to the degree of agreement attained between the performance and the eventual results of model and full-scale, while the theoretical considerations underlying the attainment of similitude in models are the subject of well-informed and progressive study. The matter is regarded as of such consequence that the Board, endorsing a previous resolution of the Research Committee, have recommended that "no alterations in design should be made without reference to the experimenting officer, and the latter should issue instructions as to the data required to be collected to prove whether a prototype is behaving as predicted by the model."

The design of falls, *i.e.*, masonry or other works through which water flows from a higher to a lower level under some degree of control, has been the subject of investigation by the Board for a number of years, but has proved of such complexity as to remain among the current and future research programmes until such time as the principles of design have been placed beyond dispute. Among the approaches to this end, the Board are studying the features of 74 successful falls already operating in India. They include examples of flumed, notched, baffle-wall and cistern-protected falls; the rate of discharge ranges from 13 cusecs to over 10,000 cusecs; and the drop of water level from less than 1 ft. to over 8 ft. Experiments made in past years, to decide which of the available alternative forms of fall is the best, have often afforded no conclusive information, and it is evident from the report that a more comprehensive study of the subject is necessary before any reliable recommendations in this direction can be made. It seems to be fairly well established, however, that the "vertical drop" or "free overfall" type is preferable to the "rapid" type, and that the length of the crest may, with advantage, be as great as possible in order to minimise the discharge per foot run of crest. In many otherwise good designs of fall, trouble is experienced from side scour or from lapping of the water, the latter being an effect which is not suitable for theoretical treatment, and is, no doubt, difficult to reproduce in models. It would result in obvious economy, of course, if designs could be recommended in advance for future fall construction, and this may be regarded as the ideal at which the

* *Annual Report (Technical) of the Central Board of Irrigation, India.* Simla: Offices of the Board.

IRRIGATION RESEARCH IN INDIA.



Board's investigations are aimed. Pending the attainment of the necessary knowledge and experience, models to suit individual conditions of projected work are being employed, in many cases with valuable immediate results, and generally with the production of instructive data regarding the comparison between model and full-scale falls.

Another important but obscure matter with which the Board are concerned is the meandering of rivers, which may be defined as the adoption of a continually varying sinuous path by the deep-water channel of an alluvial river, not imposed by external restraint. Very conflicting evidence from widespread sources has been received regarding the effects of silt burden, erosion, the nature of the soil, rapid rise in rate of discharge and the obstructions caused by weirs and bridges. Attempts are being made, by analysis of statistics, to relate the dimensions of the river with the width and length of the belt or area over which meandering takes place. A satisfactory formulation of this relation would be of evident value in preventing flooding, by indicating the distance to which marginal embankments should be retired. It is somewhat surprising to find that the slope of the land, or the hydraulic gradient of the main channel, does not figure among the factors accepted as influencing the extent of meandering, but the effect of tributary streams is evidenced by observations of European rivers, and figures among a number of subsidiary factors being considered by the research stations.

Among a variety of problems arising from the erosion and subsequent deposition of alluvial matter, the silting of reservoirs is one which is demanding a good deal of attention, for the reason that it exerts a dominant influence on their useful life. The ability to estimate rate of silting, therefore, bears directly on the size of a projected reservoir ; whence it follows that the analysis of data from existing reservoirs forms a valuable method of investigation. Since, also, the supply to a reservoir is usually taken from a river, another approach to the problem consists in considering the discharge from the river and the proportion of silt contained in its water under varying seasonal conditions. On the latter point, reliable figures are obtainable by straightforward examinations of samples drawn from the river, but the percentage by weight of dry suspended silt, so obtained, has to be converted to volume of moist silt such as reservoir deposits consist of. The determination of appropriate conversion factors for this purpose has proved a matter of great difficulty, and errors ranging from 30 per cent. to over 100 per cent. have been experienced in connection with the Elephant Butte Reservoir in the United States of America. The problem is further complicated by the effect upon the rate of silt deposition of the ratio between the capacity of the reservoir and the mean annual run-off of the catchment.

The irrigation research officers have compiled statistics for sixteen reservoirs in India and Africa, and have deduced that, when the mean annual run-off exceeds 20 times the original capacity of the reservoir, the rate of silting varies regularly with this ratio. When, however, the ratio of the mean annual run-off to the original capacity of reservoir is less than 5, it has not been possible to establish any connection between this ratio and the rate of silting. In India it often occurs that the reservoir capacity is no more than a fraction of the run-off, and the best thing that can be suggested at present is to base projected schemes on the measured silting rates of existing reservoirs which are similar as regards the nature of the catchment, the rainfall, and the reservoir capacity in relation to the mean annual run-off.

Since, unfortunately, if not unexpectedly, there is no evidence that the rate of silting decreases with the progress of silt deposition, the Board have turned their attention to methods of preventing silting, and find that this can be achieved to a valuable degree by afforestation of the catchment area. It must frequently happen, however, that irrigation reservoirs are most needed in locations where trees are difficult or impossible to grow ; and, even where this difficulty is not paramount, there is no simple means of preventing silting in a reservoir that impounds all or most of the annual run-off. Accordingly, investigations are being made of methods and effects of by-passing silt-laden flood waters, and it has been found already at a number of places in the Punjab that by suitable training of the river, along lines suggested by model experiments, silt can be excluded from reservoirs to a valuable extent. The useful effects of building curved vanes in the river upstream of a reservoir have been shown on models, but such vanes must turn the current completely and hence are difficult to install in wide approach channels. Silt traps, consisting essentially of pockets from which concentrated silt can be drained, may be usefully employed in conjunction with other measures. These and other features are illustrated by Figs. 3 and 4, herewith, which show a proposed silt extractor for Kala-bagh, situated in a specially designed flume connecting the supply river to the canal head regulator of the reservoir. At the river's edge the canal supply is drawn through three tunnels from one 60-ft. bay of the barrage. Curved vanes distribute the flow uniformly, across a trash rack, which strains out major debris, into a settling reach 500 ft. long. Beyond that comes the main extractor, extending along 1,000 ft. of flume, having a lined bed formed of longitudinal corrugations of 15-ft. pitch, with 1 to 1 side slopes, designed to lead deposited silt to orifices spaced at 18-ft. intervals along the troughs of the corrugations, and thence, through a system of branch and main drains in tunnels, through a gated outfall back into the river downstream of the barrage. Fig. 4 is a transverse section, at twice the scale of Fig. 3.

At the opposite extreme from silt come boulders and coarse gravel, of which the movements in torrents, and the effects on river flow, are among new subjects of investigation intended to supply the deficiencies of existing data. Interest attaches to the actual size measurement of coarse, incohesive river-bed material, and to the derivation therefrom of equivalent average roughness to which the resistance to flow may possibly be related. To this end, data are being compiled from Indian rivers and their examination will, it is hoped, include representative examples over the complete range of natural rugosity. These studies may well prove to have an important bearing on flood control, which is also being studied with respect to the influences of reservoirs and deforestation. To employ reservoirs both for flood control and irrigation appears rather contradictory and hitherto has been generally regarded as an uneconomic system of protection, but the Board are hopeful that a detailed investigation of the seasonal occurrence and volume of flood flows in rivers may enable a case to be made out for financial assistance from the Federal Government ; and, technically, may disclose a procedure for filling reservoirs that will hold in reserve sufficient capacity to absorb floods during the time in which they are likely to occur, and progressively release this space for replenishment as the end of the flood season approaches. The possibility of flood-control reservoirs being utilised for power development or irrigation is also being borne in mind, and most of the storage sites under consideration have been studied with a view to power development and with assistance from the Hydro Electric Survey of India. The harmful effects of deforestation, however, are fully recognised by the Board, and Provincial and State Governments have been urged to develop local machinery to deal with the problems that arise.

The technical methods of staunching canals, as a means of conserving irrigation water, have been exercising the ingenuity of engineers and research officers in India for a number of years. Measurements of canal losses have been attempted both directly, by observations of discharge at the head

and tail of the canal reach under investigation, or by measurements of the rate of loss of water from compartments; and indirectly, by observing the slope of the subsoil water in the vicinity of canals and combining this with the transmission coefficient of the soil, hence arriving at the rate of subterranean flow from the canal. The rate of subterranean flow has also been studied by chemical methods. In the main these studies have been conclusive, revealing that water loss decreases with increased size and decreased gauge of channel, but is also affected by temperature and by the depth of the subsoil water level. Among the means adopted to minimise seepage may be mentioned lining the channel, adjusting its slope, reducing its full-supply water level, and treating its soil with chemicals such as sodium carbonate. No specific form of lining can be recommended as pre-eminently suitable for general use, but the sodium-carbonate consolidation process appears to be cheap and effective, permanent reductions in loss of water approaching 40 per cent. being obtainable by treating the subsurface of the channel at the rate of 100 lb. of the salt per thousand square feet of soil. In these and other directions the Board are to continue their consideration of seepage prevention with the object of analysing fully the effectiveness and durability of the methods already practised in the field.

As one of several incidental aspects of irrigation, the Board have given attention for many years to the reclamation of water-logged land and the restoration of infertile, especially alkaline, soils. Some ten years ago, it was considered that alkaline soil could be reclaimed by lowering the subsoil water-table, except in situations where a hard and impermeable crust had formed. Field trials subsequently carried out in the Punjab, however, disclosed the existence of salty soil at ground level in localities where the water table was 40 ft. down, demonstrating that the appearance of alkali at the surface may be quite unconnected with the water table. In other cases, the lowering of the water table has not cured the alkalinity of the soil. These facts have led the Board to revise their earlier views, though positive knowledge of satisfactory methods of treating water-logged or alkaline land is as yet so far lacking that no alternative constructive recommendation has been formulated. The subject remains under intensive study, therefore, among the suggested approaches being an extensive aerial survey to plot salt-affected areas, to be carried out in the colder weather during which season the salt is more visible; and a chemical survey of the whole of India. Lack of information regarding the distribution of infertile land areas is an undoubted obstacle to a rapid solution of the general reclamation problem, but neither of these suggested schemes is likely to be possible without financial assistance from the Government. For the present, consequently, large works to alleviate water-logging cannot be undertaken without grave risk of the failure that has attended certain premature schemes in the United Provinces. There is evidence, nevertheless, that an efficient surface-drainage system for the removal of storm water can play an important part in checking the rise of the subsoil water table in areas subject to appreciable rainfall, and investigations of a statistical character into the optimum design of drains for dealing with high water table, surface and storm water, and seepage from canals, are at present in active progress.

The wide subject of deforestation, briefly mentioned earlier in connection with flooding and flood control, also has an important bearing on soil denudation, and exerts so adverse an effect on river supplies and agriculture that it has caused the serious concern of the Irrigation Board. It seems to have been established for a number of years that deforestation in India is steadily increasing the intensity and extent of floods, while reducing the dry-weather flow in rivers. Both these effects, of course, are contrary to the principal purpose of irrigation, and they can, additionally, cause damage to, or deterioration of, expensive irrigation canals and other works. In some areas they denude the land of fertile soil; elsewhere they produce harmful deposits of sand, and they can sometimes interfere disastrously with river navigation. As far as concerns the too-rapid run-off from deforested land used for agriculture, a noteworthy preventive measure that is being practised with success in the Punjab consists in digging rows of shallow, level trenches along sloping ground. These have the dual result of conserving water that would otherwise run off, while at the same time they break up rapid run-off flow which, if unrestricted, would carry valuable soil into the valleys. Once the trenches are dug and suitable vegetation established between them, the maintenance is slight and tends to become cumulatively less by the water-holding power of the plants; whereas, in the absence of such treatment, the deforested slopes tend towards denudation with accumulating rapidity. Indeed, it is asserted that a good catch of rain in the contour trenches continues to seep into the ground for several days, long after untrenched slopes are completely dry.

The contour trench is only one of a number of promising measures, some of which aim at improved field cultivation and live-stock management, that the Board are anxious to see put into operation on a generous scale with the minimum of delay. They emphasise in their report that the matter is not a provincial one, because the vital interests of more than one Province or State are bound up in the water yield from any one of the large natural drainage systems of India. In areas where soil denudation can be prevented, there should be, of course, benefits to local inhabitants and agriculture; but the Board consider that such local benefits should be secondary or subordinate to the main objective, which is the conservation of the water yield in the interests of the inhabitants of all provinces whose existence depends upon the supply of irrigation water being maintained from catchment areas that, in many cases, extend beyond the limits of control of any provincial government.

Upon this note, a brief survey of the Board's report may fitly close. Not only this question of denudation, but many of the other problems confronting irrigation engineers, can be properly solved only on a national scale and with generous financial assistance from the Central Government. The quantity and quality of the work already undertaken by the Irrigation Board, in relation to the rather slender resources as yet at their disposal, are sufficient assurance that increased expenditure on irrigation research will be a wise, and eventually profitable, step.

NOTES ON NEW BOOKS.

The Machining of Copper and its Alloys. London: The Copper Development Association.

THE range of copper alloys now available is very extensive, including alloys having widely varying physical and machining characteristics; perhaps in no other range of alloys are the machining properties so varied. It follows that the machining practice also must differ considerably for different alloys, but most reference books still give their recommendations under such indefinite headings as "Cast Brass" or "Cast Bronze." Engineers concerned with the specification of materials, and with design, need to have some idea of the machining properties of the materials they may select, and of the form in which a material can best be worked. The Copper Development Association has published this book with the object of supplying the required information. It consists of notes and data from various sources, such as technical literature, the proceedings of societies, and contributions from manufacturers of tools and producers of copper alloys. The classification of the alloys, according to the type of chip produced in machining, gives three groups corresponding to the structures of the alloys. Against the groups are set out the general machining characteristics of each, the recommended cutting speeds and feeds for different tools, and most suitable coolants and lubricants. A considerable amount of detailed information is given regarding the types of machining operation on the alloys, and, in addition to the usual cutting speeds and feeds, there are suggestions regarding types and settings of tools. All the commonly employed machining methods are described. A small section has been devoted to possible methods of working the alloys, and an attempt is made to set them out in order of machinability. In many general machine shops the amount of machining on copper alloys is small, and little attention is paid to it. Improvements in production could frequently be obtained by giving greater consideration to the problem and by applying the data contained in this book. At the present time it is likely to be particularly useful, as many machinists are now faced with the task of machining alloys outside of their normal experience. It is possible, however, that readers whose knowledge of metallurgy does not extend to the placing of an alloy in a group may spend some little time in seeking the desired information. For their benefit, a chart might have been added, giving the alloys in order of, say, the copper content, and indicating in the case of each alloy the group to which it belongs.

Locomotive Valves and Valve Gears. By CHAS. S. LAKE and A. REIDINGER. London: Percival Marshall and Company, Limited. [Price 5*s.* net.]

AN elementary book descriptive of locomotive slide valves and their gears is a useful addition to the bookshelf of any budding engineer, whether or not he is directly concerned with steam power on railways; and this small work may be commended for its comprehensive scope and the clarity of its descriptions and illustrations. The line diagrams are numerous and helpful, though the suggestion may be made that, in the case of cylinders with overhead valve-chests, the angle of inclination of the travel of the valve relatively to that of the piston should be given. Accuracy in details of this kind is particularly important in an elementary work. The subject of indicator diagrams is dealt with rather more briefly than its importance warrants. An illustration might have been added, showing a typical arrangement of indicating apparatus; description without illustration is liable to be as difficult to read as it certainly is to write. Some reproductions of actual diagrams, taken on service, would also enhance the informative value of the book.

Engineering Surveys. By HARRY RUBEY, PROFESSOR G. E. LOMMELL, and PROFESSOR M. W. TODD. New York: The Macmillan Company. London: Macmillan and Company, Limited. [Price 15*s.* net.]

THIS is a revised edition of a work first published in 1934. It is primarily intended for the instruction of students in the United States, and, in consequence, the methods are in some respects unfamiliar to students in Great Britain; for instance, compass bearings are read from 0 deg. to 90 deg. in each quadrant, instead of from 0 deg. to 360 deg., as in this country. The British method seems less likely to cause error. As a book for students, it calls for a good deal of supplementary work by the instructors. There is too little information on how to lay out a small survey so as to secure the most economical arrangement of lines; the difficulties to be overcome in chaining round obstacles or over a hillock receive no attention, and it seems to us that the illustrations of field work are too few, too simple, and not sufficiently instructive. The notes on township surveys, and the legal aspects considered, are more of local than of general interest. There are, however, some interesting details on the relative cost of surveys under various conditions, and the mathematical tables are commendably clear. Apparently, there are some 20 official departments in the United States engaged in producing survey sheets, as compared with the one British Ordnance Survey Department which supplies the equivalent material.

Engineering Inspection. By A. C. PARKINSON. London: Sir Isaac Pitman and Sons, Limited. [Price 6*s.* net.]

THE dependence of quantity production methods upon accuracy of inspection had been amply demonstrated in the motor-car and electrical industries even before the last war came to impress the fact upon a number of other branches of engineering manufacture; but, even so, the widespread character of the present national effort has gone far beyond all existing practice in precision manufacture. As a result, inspection staffs have had to be augmented extensively by the recruitment of large numbers of inspectors, who have had to be rapidly trained to undertake work of this kind, on materials and with apparatus with which they were quite unfamiliar. To them, and to those responsible for their training, the present work should make a strong appeal. Much of the ground that it covers is well known to trained engineers, but even they are likely to appreciate its numerous references to the British Standard and other specifications, and the details of up-to-date shop practice, not always to be found in publications which approach the subject of engineering production rather from the standpoint of design. A general outline of the functions of an inspection department is followed by chapters dealing in detail with limits and tolerances, the metals (including many special alloys) used in modern production, mechanical and other tests, heat treatment, testing and measuring apparatus, threads and their measurement, methods of gauging gears and measuring angles, and, finally, the various means of joining metals by soldering, brazing, riveting, and welding. The book may be commended for the success with which the many aspects of a complex subject have been summarised.

PNEUMATICALLY-OPERATED RAILWAY WIND-SCREEN WIPERS.

MESSRS. METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, MANCHESTER.

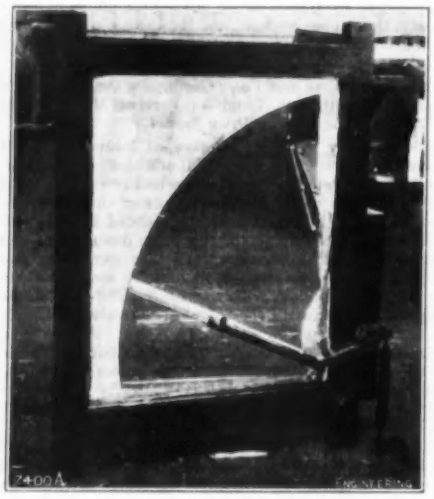


FIG. 1. HEAVY-TYPE WIPER.

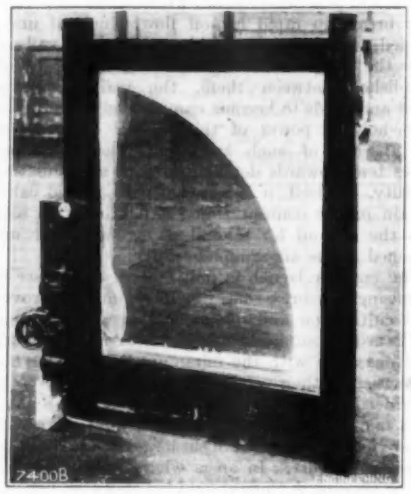


FIG. 2. PNEUMATIC ENGINE.

FIG. 3. COMPLETE ASSEMBLIES.

PNEUMATICALLY-OPERATED WIND-SCREEN WIPERS FOR RAILWAYS.

THE windscreen wiper, which is an essential part of the equipment of nearly every motor vehicle, has become so commonplace as to pass without notice or comment, but it is not so widely recognised that railways are now finding it advisable to adopt it. The driver of the steam locomotive has a good deal to put up with from the obscuration of his cab windows, but he can always, though at sacrifice of comfort, put out his head. With the electric or internal-combustion engine train, in which the driving cab is a compartment of the first vehicle and in which the driver, in most cases, is seated, this practice is neither advisable nor convenient. As long as the electric train ran within tunnels the difficulty of obscured windows did not arise, but, with the extension of electric running into the open, the problem became acute, particularly in the inclement weather of the northern parts of the country. A satisfactory solution, however, has been provided by the development of the pneumatically-operated windscreen wiper shown in Figs. 1 to 12, on this and the opposite pages, and manufactured by Messrs. Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17.

The method of operation by compressed air is convenient since air under pressure is usually available for the operation of the brakes. The wiper is made in two types, of which the heavier one is shown in Figs. 1 to 7, two views of a railway motor-coach window fitted with this equipment being given in Figs. 1 and 2. The first of these is an external view, as will be evident from the position of the wiper arm, while the second, an internal view, shows that the operating mechanism is inside the cab. Two views of the complete unit detached from the window are given in Fig. 3, while the detailed drawings, Figs. 4 to 7, will make clear the construction. It will be evident that the spindle on which the wiper arm is mounted must be given an oscillating movement and, further, from Fig. 5, that this is derived from the reciprocation of a pair of pistons connected by a rod, a pin on the rod engaging with a forked lever on the spindle inside the cylinder in which the pistons move. The pistons are fitted with cup-leather packing and the rod is extended at each end, the projections containing helical springs, enclosed in caps, which function as buffers.

The cylinder, of gunmetal, is closed at each end by a leather diaphragm which is held in place by the end covers and, on the cylinder side, is provided with a reinforcing disc. On the other side, each diaphragm is fitted with a short push-rod which is in contact with a stainless-steel ball valve. A second push-rod with a helical spring bears on the other side of the valve. The valves have a travel of about $\frac{1}{32}$ in. and each has two seats, one on each side of the ball. A port from each valve chamber leads to the space between the piston and diaphragm at the end of the cylinder opposite to it. These ports are formed by the three tubes visible in Figs. 4 and 6. The left-hand valve chamber in Fig. 5 communicates through one of them with the cylinder space beyond the right-hand piston. A second tube makes the converse connection,

Fig. 4.

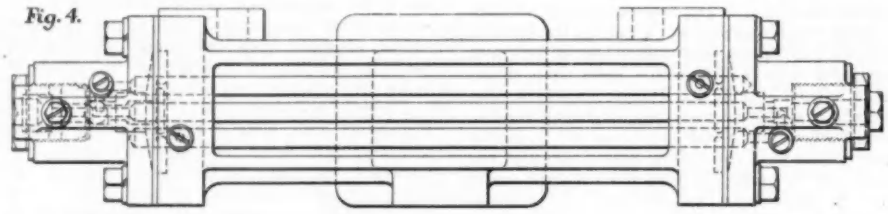


Fig. 5.

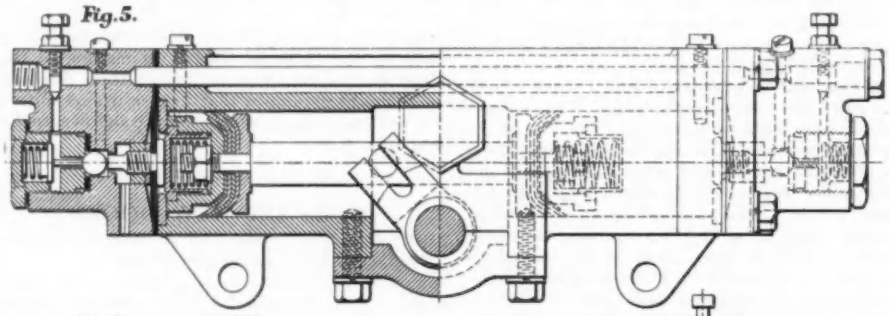


Fig. 6.

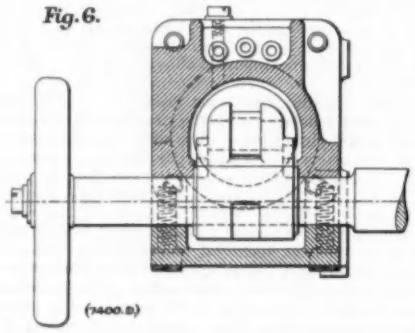
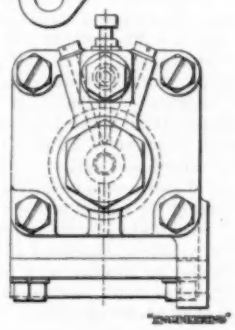


Fig. 7.



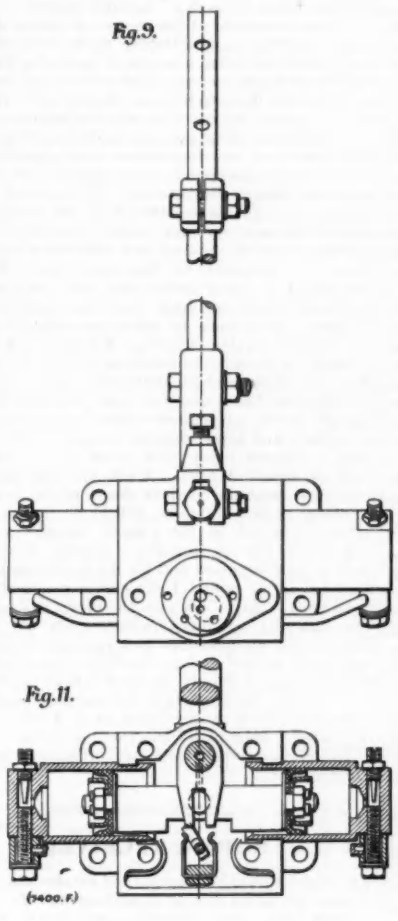
while the third tube supplies air pressure to both ends of the cylinder, this supply entering the valve chamber through the outer valve seats and the tube being connected to the source of supply by the screwed connection seen at the top left-hand corner of Fig. 5. At the same corner of this figure, at the bottom, is seen the exhaust port which leads from the chamber beyond the inner valve seat containing the diaphragm push rod. A similar port exists for the right-hand valve.

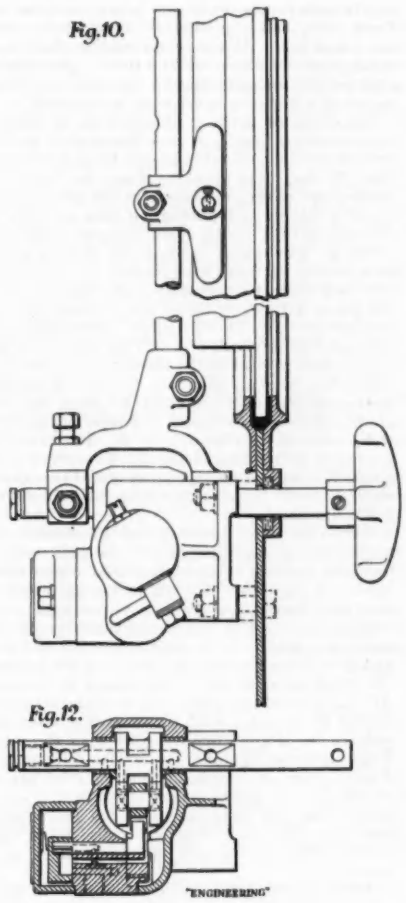
When the air supply is turned on, the pressure forces both valves on to their inner seats, thereby cutting off the exhaust passages. The air flowing past the outer seat enters both the piston spaces from the valve chambers, but the pressure builds up at a different rate in each space, a condition which may be due either to the position occupied by the double piston at the time or to minute differences in the ports or piping. In consequence of this differential effect, one of the diaphragms deflects before the other and pushes the valve concerned from its inner seat to its outer seat. If the left-hand diaphragm of Fig. 5 is deflected first, the displacement of the valve cuts off the supply to the right-hand end of the cylinder and also opens that end to exhaust. The piston then moves from left to right, since the pressure in the left-hand end of the cylinder is maintained. The reverse movement automatically follows when the right-hand piston displaces the right-hand valve. The several buffer springs counter any tendency to shock and as the valve movement is so small the diaphragms should last a very considerable time. Obviously, such a mechanism could "run away" if not controlled and the control must itself be limited. The screws seen at the extreme

PNEUMATICALLY-OPERATED RAILWAY WIND-SCREEN WIPERS.

MESSRS. METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, MANCHESTER.

FIG. 8. LIGHT-TYPE WIPER.





ends of the cylinder, at the top in Fig. 5, are adjustments which are set, before the wiper leaves the maker's works, to limit the maximum speed of working, while the small handwheel visible in Figs. 2 and 3 actuates a fine needle valve which enables the driver to regulate the speed to any value up to the predetermined maximum.

The wiper bar, it will be clear from Fig. 3, is hinged to the oscillating arm, an adjusting screw being provided to regulate the pressure of the blade on the window. The bar is fitted with a squeegee rubber, which can be readily reversed. The weight of the arm and bar is balanced by the helical spring seen in Figs. 1 and 3. This is fitted outside the window, and its tension is adjustable to ensure that operation is even and regular. The adjustment is effected by turning the spring bodily, as its end connections are made by right-handed and left-handed threads. Lubrication of the cylinder is effected by means of the screwed oil caps on the flanges seen in Fig. 4. The shaft is lubricated through oil holes in the bearings. The overall length of the cylinder is 11½ in., and though it is shown in Fig. 1, as attached to the bottom right-hand corner of the window, it can be modified as to length of blade, shape of arm, angular movement, etc.

The lighter type of wiper referred to earlier is shown in Figs. 8 to 12, above, and is carried on the front panel of the cab, that is, it is wholly external, though a small starting handwheel is arranged inside the cab, as shown in Fig. 10. In this type of wiper, while the double piston arrangement is retained, there are two cylinders mounted in line on the die castings which form the body or crankcase. The upper part of the body is provided with two bearings for the wiper spindle, as seen in Figs. 11 and 12. The wiper arm consists of a forked casting straddling the crankcase and secured to the spindle by flats and bolts. The outer end of the fork is slotted, as shown in Fig. 9, an arrangement which permits the fork to be tilted on the spindle round the rear bolt and held by an adjusting screw in the position necessary to keep the rubber squeegee in even contact with the glass. The arm is tubular and is clamped in a socket of the fork. Recesses in the arm prevent the bracket carrying the wiper bar from turning, this bar consisting of a pair of steel plates riveted together and holding the rubber squeegee. The spindle has welded to it inside the crankcase a short fork engaging with a pin on the piston rod, so that reciprocation of this rod oscillates the arm. This fork is clearly seen in Fig. 11, and below it will be observed a short lever which is swung from side to side as the pistons reciprocate by means of checks in the rod. Reference to Fig. 12 will show that the short lever is mounted on a spindle passing through the casing and carrying at its outer end a cup-shaped circular valve.

The valve swings over a face on the crankcase, which face is drilled with five holes as indicated in Fig. 9. The five holes are, respectively, ports for the two cylinders, the air supply, the exhaust and lubrication. The cylinder ends are connected to the ports concerned by short pipes, parts of which are shown in Fig. 9. The ports connected to the cylinders are the two lower ones of the three arranged in a triangle in Fig. 9, the upper one of this group being the exhaust port. The other two are for the air supply and lubrication, respectively. As regards the operation of the mechanism, the valve in Fig. 9 has nearly completed its swing to the right. The port to the left is uncovered by the valve and the air supply in the valve chamber flows through it to the left-hand cylinder. The port for the right-hand cylinder is in communication with the exhaust port through the cup of the valve. It is not difficult to see, therefore, that, as the valve is swung over by the contact of the piston-rod checks with the short lever on the valve spindle, both cylinder ports are opened alternately and automatically, and the pistons reciprocated. The action is smooth and reliable, the only difficulty likely to arise being that the piston may be in the middle of the stroke when the wiper action is stopped. The movement, however, is restarted by handwheel on the arm spindle, seen to the right of Fig. 10.

The lubricating oil for the cylinders is introduced through the port already referred to, the oil being taken into the cylinders by the air flow. A lubricator, visible in Fig. 8, enables the wiper-arm spindle bearings and faces to be oiled. The wiper arm has a sweep of approximately 80 deg. on the glass, and as the operating unit can be attached anywhere round the window a wide choice of wiped area is available. Some of these positions, however, involve the use of a bent arm instead of the straight one shown. The position of the wiped area can also be adjusted by moving the bar bracket up or down the arm. Both types of windscreen wiper are designed to withstand difficult operating conditions, including those imposed by modern methods of railway-carriage cleaning.

DRAFT SPECIFICATION FOR INTERNAL MICROMETERS.

A THIRD draft specification of internal micrometers, identified by the reference CF (ME) 6964, is now being circulated for technical comment by the British Standards Institution, 28, Victoria-street, London, S.W.1. As hitherto, this draft specification is not yet to be regarded or used as a British Standard, but it is felt that persons interested in the subject should be given an opportunity for constructive criticism. Any such comments should be addressed to the Institution as above, and should be posted so as to reach it before December 18, 1940.

The primary object of the specification is to prescribe standards of accuracy, and design has only been touched upon as far as it concerns the initial accuracy of the instrument and its maintenance, or facility in use. An adequate degree of rigidity being essential, it is considered that some form of practical test should be included. A test is suggested, with recommendations as to the values obtained for it, and is given in an appendix to the specification. The scope of the specification covers internal micrometers comprising a measuring head; extension rods, with or without spacing collars; and, in the smaller sizes, a handle. Provision is made for three sizes of measuring heads in both inch and metric units. For the first-mentioned, the range of micrometer screw is from ½ in. to 1 in. and the usual ranges of the instrument when used with extension rods are given as from 1 in. to 12 in., or more. With metric units, the range of micrometer screws is from 6·5 mm. to 25 mm., the ranges with extension rods being from 25 mm. to 300 mm., or more.

The body of the measuring head is to be of suitable quality steel, the spindle and terminal measuring face being of high-grade tool steel. The face is to be hardened to a diamond-pyramid hardness number of not less than 800, the approximate equivalent hardness number on the Rockwell C scale being 62. Preferably, the measuring face should be tipped with tungsten-carbide, or other hard alloy, or should be chromium-plated. The radius of this face is to be slightly less than half the smallest measuring range of the micrometer. The

screw is to have a pitch of 0·025 in. or of 0·5 mm., and preferably should have its threads, as well as those of the nut, truncated so as to confine contact to the flanks. The micrometer as supplied is to have the screw lubricated with a thin non-corrosive oil, and the screw is to run smoothly throughout the length of travel. Means are to be provided so that the thimble is sufficiently tight for the reading to be retained after setting. There must be no perceptible backlash between the screw and nut. At maximum reading there must be full engagement of the nut and screw. Means are to be arranged for compensating for wear between these two parts and a key or spanner is to be provided.

The diameter of the graduated edge of the thimble is to be not less than $\frac{7}{16}$ in., and the angle of the bevel to the axis is to be preferably 15 deg., in any case not more than 20 deg. The distance from the barrel to the reading end of the graduation on the thimble must not exceed 0·015 in. All graduation lines are to be clearly cut and have a width lying between 0·006 in. and 0·008 in. For ease in reading, the thimble and barrel may have a dull finish with blacked-in graduation lines. For inch-reading micrometers the thimble is to be graduated with 25 divisions, each reading 0·001, with numbers at 0, 5, 10, 15 and 20. The barrel is to be graduated at intervals of 0·025 in. with a longitudinal fiducial line parallel to the spindle axis. The first and every fourth graduation are to be numbered. The metric-reading micrometer is to have the thimble graduated with 50 divisions, each representing 0·01 mm. and numbered 0, 5, 10 . . . 45. The barrel is to be graduated at 0·5-mm. intervals. Every first and tenth graduation are to be numbered and distinction to be made between lines representing full millimetres and half millimetres.

Extension rods, enabling any measurement to be made throughout the ranges specified are to be included, spacing collars being used where necessary. Each rod may have its own measuring anvil, or the rods may function as distance pieces with a separate common anvil. The method of assembly of rods and measuring head is to be simple, positive and accurate, and it is recommended that each rod be marked with the range of measurement for which it is applicable. At each joint of the assembly one of the abutting faces should be provided with dirt-clearance grooves. The rods to be of good quality steel with the measuring faces hardened or tipped as for the micrometer face. Finger grips of heat-insulating material are recommended. The spacing collars are to be of good quality steel. The end faces are to be flat and square with the axis. The rod faces and collar faces are to be finished by lapping and all sharp edges are to be removed.

Each micrometer is to be provided with means for adjusting the zero setting, the adjustment, for which keys or spanners are to be provided, being such that it remains secure after re-setting and does not impair the original setting of the instrument. With extension rods each having its own measuring face individual adjustment is to be provided for zero setting. With the distance-piece type of rod the zero-setting adjustment may be incorporated either in the anvil piece or the measuring head. As regards accuracy, each measuring head with its associated extension rods, and collars, if used, when tested at the standard reference temperature of 68 deg. F., shall have a maximum permissible error in length ranging from ±0·0002 in. to ±0·001 in., according to the measuring range, or of ±0·005 mm. to ±0·025 mm. The measuring head shall not show a greater range of error in the traverse of the micrometer screw than 0·0001 in. or 0·003 mm. The range of error in the calibration of the micrometer screw is to be independent of the zero setting.

The specification states the requirements for handles, containing box or case, and packing. The appendix, as already stated, deals with a test for rigidity. Experience has shown that internal micrometers with extension rods may be deficient in rigidity. It is hoped to include in the final specification definite requirements to ensure rigidity without adding unduly to the weight of the instrument, but the simple test described in the draft specification is put forward to show what are the maximum deflections it is desirable to permit. The micrometer, with its various assemblies of extension rods and spacing collars, is supported as near the extremities of the assembly as possible, and a load of 1 lb. is applied at the mid-point between the supports. The resulting deflection should not exceed 0·002 in. for an assembly 6 in. long, with an increase of 0·002 in. for each increase in length of 1 in.; thus, for an assembly 30 in. long the maximum deflection would be 0·05 in.

PRODUCTION OF MOTOR CARS IN THE UNITED STATES.—During the week ending October 26, the production of motor cars in the United States totalled 117,080 vehicles, compared with 114,672 in the preceding week and 78,210 in the corresponding week of 1939.

THE MACHINE TOOL APPEAL.

As a result of the Machine Tool Week appeal by Mr. P. H. Mills, the Controller of Machine Tools, Ministry of Supply, referred to on page 373, *ante*, many more machines will be fully engaged on war work. Among the replies received there have been some offering old machines that could not possibly be adapted to the requirements of the modern machine shop, and others offering many valuable tools not now in full use. A further letter was posted yesterday to 120,000 firms of all kinds, so that nothing which can be used in the national effort shall escape the survey. The letter, which is signed by Mr. Mills, reads as follows:—

"In spite of the great response to the appeal which was made from this department three months ago, for the voluntary release of all machine tools not fully employed, large numbers are still required. Every machine tool in the country must be engaged every possible minute on war work. Machines such as capstans, turrets, milling and horizontal boring machines are required for the production of aircraft components; centre lathes, etc., for bomb and shell-making; heavy machine tools for tank and ship-building. Thousands of other machines of all types are required by the Ministry of Labour for the very necessary training of operatives on which your own supply of skilled labour depends. Last week I made through the Press and over the Wireless, a further appeal asking all manufacturers and firms having workshops and repair depots, to place at the Government's disposal every tool which is not being fully used on essential work. There are still many firms who have machines in their shops, useful, perhaps, on occasions or as a stand-by, but which can be infinitely better employed in the present emergency. I am responsible for the immediate supply of all suitable tools to new factories, and for the replacement of plant damaged in air raids. I can assure you that the need is pressing. May I ask you, therefore, that—whatever the difficulty or inconvenience—you act at once. Please offer all machines you can make available to used machine tool dealers operating under licence from the Ministry of Supply, or send details to me. I will then arrange for inspection and for the distribution of all suitable tools in directions where I know the need is greatest. Prompt payment will be made."

The address of the Ministry of Supply is Adelphi, London, W.C.2.

BOOKS RECEIVED.

The Association of Engineering and Shipbuilding Draughtsmen. Determination of Scantlings for Masts, Derrick Posts, and Their Fittings. By D. M. CARNEGIE. 1, Links-road, Epsom, Surrey: The Draughtsman Publishing Company, Ltd. [Price 2*s.* net.]

United States War Department. Transportation Series No. 5. *Transportation Lines on the Atlantic, Gulf and Pacific Coasts*, 1940. Washington: Superintendent of Documents. [Price 50 cents.]

Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Year Ended 31st March, 1939. *With Report of the Director of Fuel Research.* London: H.M. Stationery Office. [Price 3*s.* 6*d.* net.]

Department of Scientific and Industrial Research. Methods for the Detection of Toxic Gases in Industry. Leaflet No. 12. *Organic Halogen Compounds.* London: H.M. Stationery Office. [Price 2*d.* net.]

The Ohio State University. The Engineering Experiment Station. Bulletin No. 106. *Photoelastic Analysis of Two- and Three-Dimensional Stress Systems.* By BERNARD FRIED and PROFESSOR ROYAL WELLER. Columbus, Ohio, U.S.A.: The Director, The Engineering Experiment Station, The Ohio State University. [Price 40 cents.]

CONTROL OF FERTILISERS.—The Ministry of Supply has issued the Control of Fertilisers (No. 7) Order, 1940, and the Direction No. 6 under the Control of Fertilisers (No. 1) Order, 1939. These fix maximum prices, for the remainder of the season, in respect of sulphate of ammonia, superphosphate and compound fertilisers.

ENGINE-ROOM ARTIFICERS FOR THE ROYAL NAVY.—The Admiralty has informed us that men with not less than four years' experience as fitters, fitters and turners, coppersmiths, boilermakers and engine smiths, between the ages of 19½ and 40, who, though in a reserved occupation are not employed on work of primary national importance, may now be accepted as engine-room artificers in the Royal Navy for the period of the present emergency. They should apply to their nearest combined recruiting centre, the address of which may be obtained at any employment exchange of the Ministry of Labour and National Service.

PERSONAL.

THE Government having released SIR CHARLES CRAVEN from his duties at the Ministry of Aircraft Production, he resumed his positions on the boards of Messrs. Vickers Limited, and associated companies on November 7.

MR. W. J. CHARLTON, H.M. Divisional Inspector of Mines, Northern Division, retired on October 31. His successor is MR. ROBERT YATES. MR. P. T. JENKINS, senior inspector, has been appointed Inspector in Charge of the Swansea Division in succession to Mr. Yates.

MESSRS. COX AND DANKS, LIMITED, have opened an office for dealings in iron and steel scrap at Prudential Buildings, Mill-street, Bedford. MR. L. WALLIS has been made manager.

MR. A. CUNNINGHAM was recently installed as President of the Falkirk Section of the Institute of British Foundrymen (Scottish Branch) by the retiring President, Mr. J. A. DONALDSON.

LORD AUSTIN OF LONGBRIDGE has been re-elected President of the British Cast Iron Research Association.

PROFESSOR E. T. WHITTAKER has been elected President of the Royal Society of Edinburgh, and PROFESSOR J. P. KENDALL, general secretary.

MR. J. M. ORMISTON, shipbuilding manager of Messrs. Vickers-Armstrongs Limited, has been elected President of the Shipbuilding Employers' Federation, 1, Chester-street, Grosvenor-place, London, S.W.1.

MR. W. H. MCMENEMEY, engineering manager of Messrs. Cammell Laird and Company, Limited, Birkenhead, has been appointed a director of the Company.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The market in raw and semi-finished materials is active. The consumption of pig iron and hematites is not greater than is justified by the present supplies of raw materials, and steel producers have no anxiety regarding the future. The call for both basic and acid steels is increasing. Makers of sections, joists, and plates are meeting the heavy demands, and plants turning out structural steel are operating at full capacity. There is a good home market for various types of sheets, though export requirements show little expansion. Rolling mills, forges, and press shops are busy, and re-rollers are accounting for larger outputs. Inquiries at steel and engineering works reveal that, while Government requirements continue to increase, there is a steady flow of orders for ordinary commercial products. The demand for ironworks and steelworks equipment is heavy. Contracts are on hand for rolling mills, hydraulic presses, lathes, and various types of machinery. Sheffield sales to South Africa have shown a steady rise during the past few months. The heavy forges are busily employed in turning out hollow forgings and boiler drums, and there is considerable activity at works producing agricultural machinery parts and implements. The makers of electrical equipment are busily employed, and improvement is reported in the demand for railway axles, springs, tyres, buffers, carriages and wagons. The lighter trades are satisfactorily engaged. Record outputs of clutch plates, gearboxes, machine tools, and engineers' small tools are reported.

South Yorkshire Coal Trade.—Though stocks of coal in this area are larger than at this time last year, merchants are pressing the Government to put down large dumps as stores for the winter and for emergency use. The general trade in coal shows little change. An active business is being done in industrial coal. Steam coal is in demand, and there is a good market for smalls and slacks. The demand for house coal is increasing. Foundry and furnace cokes are active lines.

THE DEVELOPMENT OF THE KAPLAN TURBINE: ERRATUM.—We regret that the 3 was omitted from the cube-root sign in formula (6) of the article bearing the above title, as printed on page 382 of our issue of November 15. Doubtless the omission will have been obvious, from the fact that a similar formula was correctly printed immediately above formula (6).

REFRIGERATION INSULATION MANUFACTURERS' ASSOCIATION.—An Association to be known as the Refrigeration Insulation Manufacturers' Association has been formed to promote and protect business in commercial refrigeration insulation and kindred insulated products, to establish fair and reasonable conditions of sale, to encourage propaganda and to act generally with other kindred bodies, particularly the Commercial Electric Refrigeration Association. Membership of the new Association is open to all approved manufacturers, in Great Britain, of insulation for thermal control, and those interested and qualified are invited to get in touch with the secretary, Mr. Felix A. Rogers, 36, Kingsway, London, W.C.2

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—There has been little change in the state of the Scottish steel trade during the week. The consumption of plates, sections, etc., by the shipyards amounts to a large tonnage and there is constant pressure for deliveries. Active conditions continue in the black-steel sheet trade and as the supply of raw material is ample, at present, a large output is being maintained. Orders of an urgent nature are numerous, especially for galvanised varieties. The following are the current quotations:—Boiler plates, 17*l.* 0*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ½ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton.

Malleable-Iron Trade.—The malleable-iron trade of the West of Scotland is satisfactory and order books are well filled. The recent scarcity of malleable-iron scrap has been overcome and production is now proceeding normally. The re-rollers of steel bars are fully occupied and consumers are pressing for deliveries against contracts. The supply of semies has improved, and plant is being operated at its maximum capacity. The current market prices are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton.

Scottish Pig-Iron Trade.—Activity still continues in the Scottish pig-iron trade and the demand from consumers of steel-making iron is such that stocks at the furnaces are not allowed to accumulate. All the furnaces in blast are working continuously and as the supply of ore now in hand is ample for the present and for the immediate future, the output is being maintained on a large scale. Steel makers are pressing for deliveries but foundrymen are not taking up a heavy tonnage. The following are to-day's market quotations:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; and foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' works.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—The claim of the South Wales coalfield for an increased share of the home trade was made again during the past week. It formed part of a memorandum which the Miners' Federation has prepared with the object of assisting the industry through the difficult times it is now experiencing. The memorandum, which was adopted at a special coalfield conference, will be placed before the Government departments concerned. The memorandum contended that South Wales had not benefitted to any great extent as a result of the increased consumption of coal in the home market, and expressed the opinion that considerably more South Wales coals could be sent to areas which were nearer to this coalfield than to any other. This was especially the case in view of the fact that the other coalfields were experiencing difficulty in satisfying the demand. In particular, it was claimed that the South and West of England were areas which should be supplied from South Wales. Another important matter touched upon in the memorandum was the importance of fostering trade with the South American countries. It was stated that there was a considerable demand for coals from this direction, and also that there were possibilities for an outlet for some coal in the United States, but the high prices charged, due to high war-risk insurance and the heavy freightage charges, prevented these supplies from being provided by this country. Home consumers were again displaying considerable interest in the high-volatile bituminous coals for industrial purposes. Most collieries producing these coals were well employed and order lists were well filled for some time to come. Dry steam coals, however, remained in slow request. The foreign demand was again slow and gave little indication of an early improvement. Best large coals were steadily absorbed, and the popular sized sorts again attracted a keen interest, but were difficult to secure. There was a shortage of bituminous small coals, but dry smalls were in plentiful supply and dull. Cokes were busy.

The Iron and Steel Trade.—Activity in the iron and steel and allied trades was well maintained during the past week. There was a steady demand and works had sufficient orders to keep them fully occupied for some time to come. Most concerns were working almost to full capacity.

THE MERSEY TUNNEL.—Satisfactory arrangements having been made with Merseyside authorities, it is intended that the Mersey Tunnel should be used by omnibuses in the event of an emergency.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Although the general situation in the iron and allied trades has improved, conditions are not conducive to the transaction of business. Buyers have placed numerous orders at the recently advanced prices and have still extensive contracts to arrange, but producers of most commodities have fully sold their output to the end of the year and are unable to consider offers of business except for delivery beyond the supply allocation period. Orders already booked are likely to involve some carry over of work into next year. The continued ample supply of raw materials is keeping semi-finished and finished manufacturers fully employed, but the output is passing promptly into use and consumers of many descriptions of material are calling for still larger deliveries. Rationing of customers is still necessary to ensure that adequate tonnages reach the firms directly engaged on work of national importance.

Cleveland Iron Trade.—No appreciable expansion of the light intermittent make of Cleveland pig can be reported, but deliveries from other producing centres are substantial and the requirements of North-East Coast founders are adequately covered. Extensive use of Midland iron in this area continues and satisfactory parcels of Scottish and other brands are still obtainable for special purposes. Merchants are handling more tonnage than has been the case for some little time, but the volume of business passing through second hands is still very limited. Fixed prices of Cleveland pig are ruled by No. 3 quality at 128*s.*, delivered to local buyers.

Hematite.—American hematite is coming to hand to assist in meeting the heavy and expanding demand. The maximum make of East-Coast iron is absorbed as it becomes available and consuming works owned by hematite producers, as well as the plants of firms who are dependent on the market for supplies, could take increased deliveries. In the near future the tonnage available is expected to be sufficient for the growing requirements. The recognised market values are governed by No. 1 East Coast hematite at 138*s.* 6*d.*, delivered to North of England customers.

Basic Iron.—All the basic iron output is still retained for use at the makers' own steelworks and in the absence of saleable tonnage the quotation remains nominal at 120*s.* 6*d.*

Foreign Ore.—Stocks of foreign ore are still large and imports are expected to improve.

Blast-Furnace Coke.—Buyers and sellers of Durham blast-furnace coke are not disposed to discuss new business. The former are extensively sold and the latter have covered their requirements as far ahead as they consider advisable.

Manufactured Iron and Steel.—Imports of semi-finished and finished products from the United States, added to the supply from the home works, are sufficient to meet the heavy requirements of the consumers. Regular large deliveries of semies are keeping the re-rolling mills fully occupied. Finished-iron firms are well sold and finished-steel producers find it necessary to operate their plant at full capacity to meet their customers' requirements. The delivery of materials to enable the extensive shipbuilding programme to be carried out is satisfactory. Soft-steel billets are quoted at 12*l.* 5*s.* per ton; hard billets at 13*l.* 12*s.* 6*d.* per ton; joists and sections at 15*l.* 8*s.* per ton; heavy plates at 16*l.* 3*s.* per ton; and heavy rails at 14*l.* 10*s.* 6*d.* per ton.

Scrap.—Users of iron and steel scrap have large stocks, but are still accepting deliveries.

CONSUMPTION OF TIN IN THE UNITED STATES.—The total quantity of tin purchased by consumers in the United States, in 1939, was 89,018 long tons, representing an increase of 45 per cent. over the figure for 1938.

ENGINEERING POCKET BOOK.—Under the title *Useful Tables for Engineers and Steam Users*, an engineering pocket book, published by Messrs. Babcock and Wilcox, Limited, Farringdon-street, London, E.C.4, has now reached its tenth edition. The book is certainly adapted for the pocket, but its small size and slimness does not indicate meagre contents; on the contrary, it is somewhat surprising what an amount of material has been got into 155 pages. A particularly useful feature of the book is its comparative tables; for instance, the standard sieve sizes of six different practices are given side by side. The same applies to standard plate and wire gauges, to hardness of water, and other subjects in the classification of which diverse practice is followed. Most books give one or two standards and it is not an unusual experience to find that the particular one wanted is missing. English and metric systems for such things as pressures per unit area and the properties of steam also appear virtually side by side. Naturally, the major portion of the book is devoted to tables concerned with power generation.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF CIVIL ENGINEERS.—*Yorkshire Association:* Saturday, November 23, 2.30 p.m., The Hotel Metropole, King-street, Leeds. Ordinary Meeting. Dugald Clerk Lecture: "Modern Methods of Excavation Work at Home and Abroad," by Mr. William Barnes.

MANCHESTER ASSOCIATION OF ENGINEERS.—Saturday, November 23, 2.30 p.m., The Engineers' Club, Albert-square, Manchester. "Line Production of Machine Tools," by Mr. O. Rendell.

ROYAL SOCIETY OF ARTS.—Monday, November 25, 1.45 p.m., John Adam-street, Adelphi, W.C.2. Cantor Lectures—II. "Recent Developments in Internal-Combustion Engines," by Professor S. J. Davies.

INSTITUTION OF ELECTRICAL ENGINEERS.—*Scottish Centre:* Tuesday, November 26, 6.15 p.m., The Royal Technical College, George-street, Glasgow, C.1. Informal Discussion on "Potentiometer Calibration of Sub-Standard Instruments," to be introduced by Mr. J. S. Tait. *South Midland Students' Section:* Wednesday, November 27, 6.30 p.m., The James Watt Memorial Institute, Birmingham. Ordinary Meeting. Discussion on "Modern Methods of Industrial Drives."

INSTITUTION OF AUTOMOBILE ENGINEERS.—*Birmingham Centre:* Tuesday, November 26, 7 p.m., The James Watt Memorial Institute, Great Charles-street, Birmingham. General Meeting. "Notes on Filtration and Distribution of Lubricating Oil," by Mr. T. C. Worth. *Birmingham Graduates' Branch:* Friday, November 29, 7 p.m., The James Watt Memorial Institute, Great Charles-street, Birmingham. "Balancing in Automobile Engineering," by Mr. G. D. Campbell.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.—Thursday, November 28, 7 p.m., The James Watt Engineering Laboratories, The University, Glasgow. "Rectification of Wearing and Repair to Mechanical Parts of a Locomotive," by Mr. J. S. Scott.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, November 29, 6 p.m., The Mining Institute, Newcastle-upon-Tyne. "Mechanical Gearing for Large Power Transmission," by Mr. L. M. Douglas.

JUNIOR INSTITUTION OF ENGINEERS.—Saturday, November 30, 2.30 p.m., 39, Victoria-street, Westminster, S.W.1. Ordinary Meeting. "Tide Mills in England and Wales," by Mr. Rex Wailes.

INSTITUTE OF BRITISH FOUNDRYMEN.—*Scottish Branch, Falkirk Section:* Saturday, November 30, 6 p.m., The Temperance Café, Lint Riggs, Falkirk. "This and That," by Mr. T. Tyrie.

ROAD FATALITIES IN GREAT BRITAIN.—During the month of September, 909 deaths were caused by road accidents in Great Britain. This total shows an increase of 24·7 per cent. on the figure for August, namely, 729. Of the September fatalities, 385 occurred during the hours of darkness, whereas the corresponding total for August was 265. In the two months of August and September there were 1,638 fatalities, compared with 1,751 in the same two months of 1939.

JUBILEE OF THE FIRST "TUBE" RAILWAY.—The City and South London Railway, the first tube railway in London and, in fact, in the world, was opened for traffic on November 4, 1890, by King Edward VII, then Prince of Wales, and therefore has recently attained its jubilee. It was constructed under the direction of James Henry Greathead, who gave his name to the excavating shield which has been so largely used in the building of its successors, and at first extended from King William-street in the city, under the Thames to Stockwell, a distance of about three miles. It was decided to operate it by electric traction, a three-wire direct-current system at about 1,000 volts across the outers being chosen for this purpose, and locomotives with the motor armatures mounted direct on the track-wheel axles being used for haulage. One of the original locomotives is now in the Science Museum, London, while another is at Moorgate station. The line was extended from London Bridge to Moorgate in 1900, the portion from the former place to King William-street being abandoned. Other extensions were made to Islington in 1901, to Euston in 1907, and southward to Clapham Common in 1907. In 1913 the line became part of the Underground group and the tunnels were enlarged to the standard diameter of that system in 1922-24. Connections were also made with the Northern line at Camden Town and Kennington, while two years later an extension was made southwards to Morden and a short link opened between Kennington and Charing Cross. The line now, of course, forms part of the system of the London Passenger Transport Board.

PRECISION JIG DRILLING AND MILLING MACHINE FOR SMALL WORK.

MESSRS. SIGMA MANUFACTURING COMPANY, LETCHWORTH.

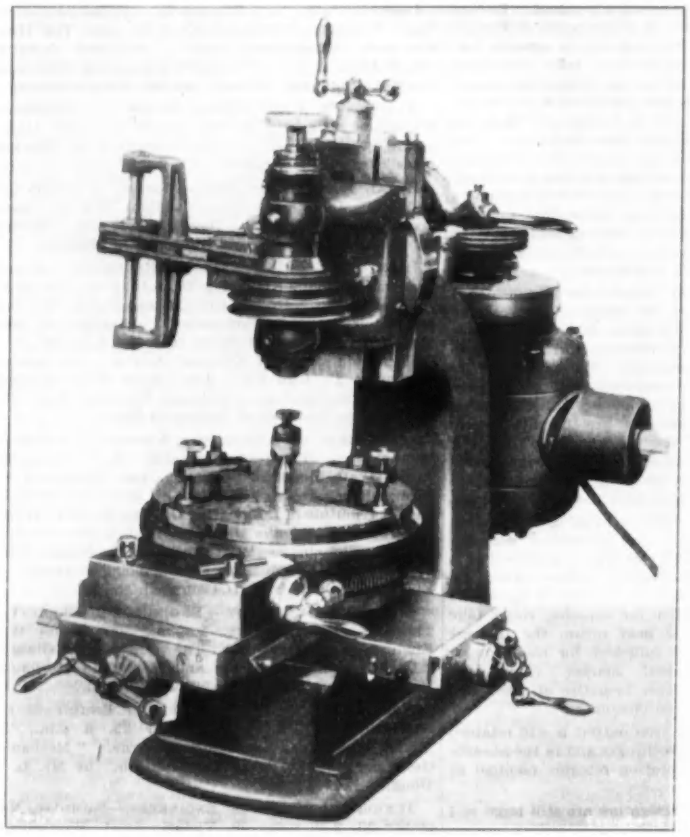


FIG. 1.

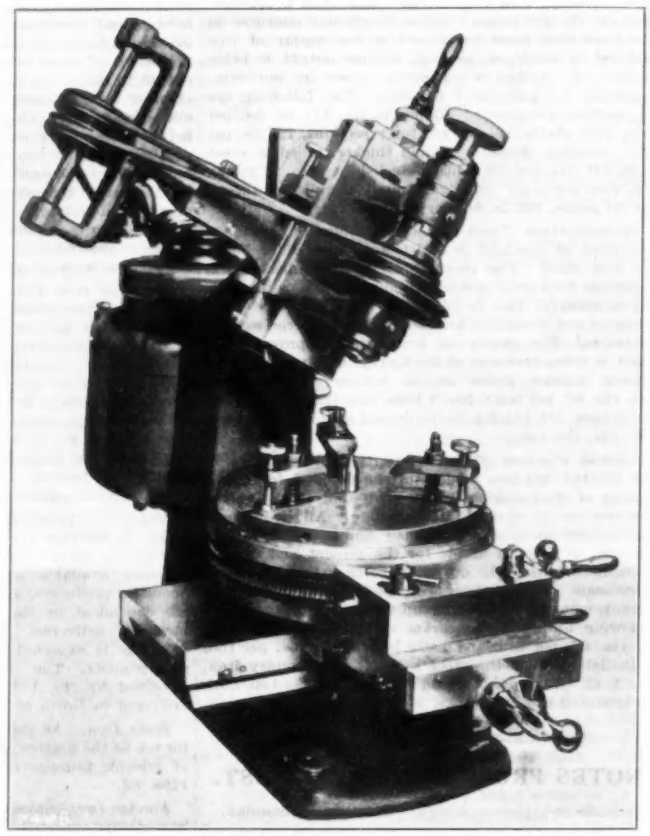


FIG. 2.

PRECISION JIG DRILLING AND MILLING MACHINE.

THE small precision jig drilling and milling machine illustrated in Figs. 1 and 2, on this page, bears a strong resemblance to a previously-imported machine made by the German firm of Boley and Leinen. The original machine was popular in this country before the outbreak of hostilities as there was no British equivalent, though there was no reason why it should not have been manufactured here. Messrs. Sigma Manufacturing Company, Letchworth, have now produced a copy of the German machine, made to British Standard tolerances, and, therefore, with interchangeable parts, the resemblance referred to above thus being deliberate and not fortuitous. It will be obvious from the figures that the machine is not intended for large work but is particularly suitable for use in the tool room and for the manufacture of dies, gauges, jigs and similar precision work. The several setting adjustments are all provided with micrometer scales, so that marking off and centre-punching the work are eliminated.

The spindle, which has a hole $\frac{7}{16}$-in. in diameter through it, has an axial traverse of $3\frac{1}{4}$ in., the maximum and minimum distances between the spindle nose and the table top being $5\frac{1}{2}$ in. and 2 in., respectively. The maximum distance from the spindle centre to the face of the column is 8 in. The head has a swivelling movement of 45 deg. on each side of the vertical. The table, which is 8 in. in diameter, is fully rotating and is mounted on a compound slide which provides for 8 in. longitudinal and 8 in. cross traverse. The slides are traversed, by means of crank handles, through accurately-cut lead screws and adjustable bronze nuts. The screws are fitted with collars graduated in thousandths of an inch, rough setting being effected by scales along the lower edges of the slides. The table periphery is provided with a scale graduated in degrees for coarse adjustment, fine adjustment being effected by means of a collar on the actuating-worm spindle, and the collar being divided into intervals of two minutes. The worm is fully protected and meshes with a worm-wheel mounted on the table edge. The surface of the table is formed with three radial tee-slots taking the cramps shown, this method of securing work having proved effective for most of the jobs that can be done on the machine.

The swivelling head is shown in a tilted position in Fig. 2, this view illustrating very well the guide pulleys transmitting the spindle drive; the motor, of $\frac{1}{4}$-h.p., is fixed to the back of the column. The guide pulleys are controlled by a balance weight inside the column; this secures effective tensioning. Setting of the head at the desired angle is accomplished with the aid of a graduated scale. A vertical scale on the edge of the slide enables the head to be set as required relative to the surface of the table, the movement being effected by screw and crank handle. Precise vertical feed for the depth of milling cut or drilling is secured by a collar on the head leadscrew, which is precision cut, graduated in thousandths of an inch. The head is secured in a truly vertical position by means of a parallel-locating dowel pin. The cutter spindle is of hardened and ground steel and heavy-duty self-aligning ball bearings on both sides of the top bearings take up end thrust. The journal bearings are split and are of phosphor-bronze seated in taper housings, lock nuts enabling the spindle centring to be adjusted. The spindle nose is arranged for collet mounting, a number of types of collet being available. The motor is designed to operate on standard three-phase, 50-cycle current. Lubrication of all bearings, slides, etc. is effected by grease gun. The machine is distributed for Messrs. Sigma Manufacturing Company by Messrs. E. H. Jones (Machine Tools), Limited, Edgware-road, The Hyde, London, N.W.9.

PANAMA CANAL TRAFFIC.—During the year ending August 31, 1940, 5,260 vessels carrying 27,299,614 tons of cargo passed through the Panama Canal, compared with 5,981 ships and 28,372,029 tons of cargo in the preceding 12 months.

STEEL PRODUCTION IN THE UNITED STATES.—During the week ending October 26, the output of steel ingots and castings from steelworks of the United States was equivalent to 95·7 per cent. of the production capacity of the steelworks. This percentage is the highest for 11 years.

THE TINNING OF PISTON RINGS.

THE advantages of coating with tin a metal surface which is in sliding contact with another metal are now well known, and tinned aluminium pistons are in general use by many motor-car manufacturers, both in Europe and the United States. It was evident that similar benefits would be obtained by tinning piston rings, but for some time attempts to produce satisfactory tin coatings on these components were not successful. It is stated, in the current issue of *Tin and Its Uses*, which is a quarterly review issued by the Tin Research Institute, Fraser-road, Greenford, Middlesex, that the problem has now been solved and a number of firms are tinning piston rings. Some notes on the method employed by Messrs. Light Production Company, Limited, 60, Rochester-row, London, S.W.1, are given. The piston rings are ground accurately to size, making an allowance for the thickness of the tin deposit which is subsequently applied. As a result of the grinding operation, the periphery of the ring has a surface composed mainly of disturbed and flowed material, which would be liable to become detached and cause wear in service. In the next operation any grease present on the rings is removed in a hot alkaline bath, and they are then etched in an acid bath. The etching treatment frees the surface from loosely adherent and smeared material left by the grinding operation and leaves a pitted surface consisting of small hollows or depressions. The rings are then washed thoroughly and given a coating of 0·0005 in. (0·012 mm.) of pure tin in an electro-tinning bath of the alkaline-stannate type. After final washing and drying the rings are ready for use.

It is stated that the pitted structure of the tinned surface possesses a number of advantages. In the first place, it assists in retaining the lubricating oil on the ring during the formation of the Beilby layer. Furthermore, the coating of tin is sufficiently plastic to flow at the points of greatest pressure and thus prevents scoring while the surfaces are running in and the Beilby layer is being formed. It is emphasised that the combination of a hard network of iron phosphide, present on the surface, with plastic pure tin resembles ordinary bearing metals in which relatively hard particles are embedded in a softer matrix.

SOIL EROSION BY WIND ACTION IN THE UNITED STATES.

(*For Description, see Page* 401.)

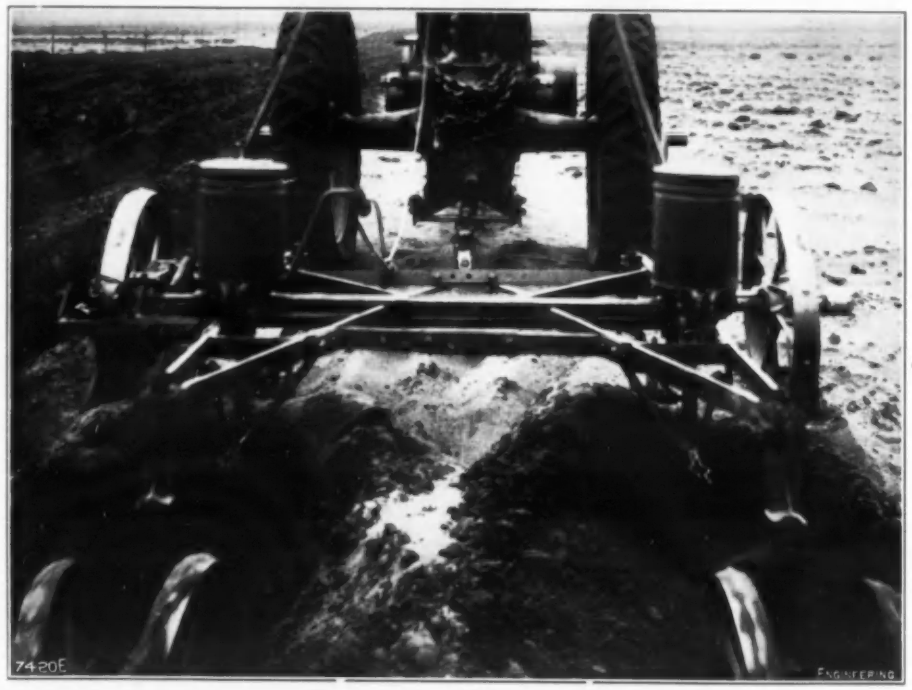


FIG. 20. LISTER IN OPERATION; SOUTH DAKOTA.

FIG. 21. BREAKING-UP GROUND WITH LISTER; KANSAS.

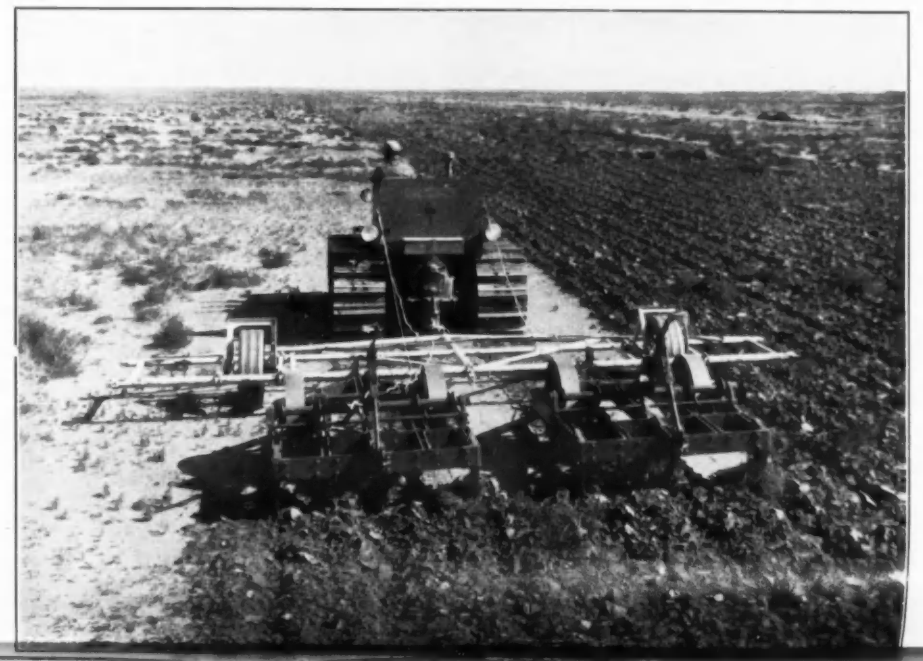


FIG. 24. PLANTING GRASS SODS; ARKANSAS.

FIG. 25. WINDBREAK FORMED OF LOMBARDY POPLARS; OREGON.

FIG. 26. WINDBREAK OF POPLAR AND EVERGREENS, NORTH END; NEBRASKA.

FIG. 27. WINDBREAK OF POPLAR AND EVERGREENS, EAST END; NEBRASKA.

UNIV. OF MICH.

ENGINEERING.

Offices for Publication and Advertisements, 35 & 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS { "ENGINEERING," LESQUARE LONDON.

TELEPHONE NUMBER—TEMPLE BAR 3663 (2 lines).

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months (or for six or three months, *pro rata*), payable in advance :—

For the United Kingdom	£3 5 0
For Canada—	
Thin paper copies	£2 18 6
Thick paper copies	£3 3 0
For all other places abroad—	
Thin paper copies	£3 3 0
Thick paper copies	£3 7 6

Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns, of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The Proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

All accounts are payable to "ENGINEERING," Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

CONTENTS.

	PAGE
Soil Erosion by Wind Action (*Illus.*)	401
Literature.—Production Engineering: Jig and Tool Design	402
Irrigation Research in India (*Illus.*)	403
Notes on New Books	405
Pneumatically-Operated Wind-Screen Wipers for Railways (*Illus.*)	406
Draft Specification for Internal Micrometers	407
The Machine Tool Appeal	408
Books Received	408
Personal	408
Notes from South Yorkshire	408
Notes from the North	409
Notes from the South-West	409
Notes from Cleveland and the Northern Counties	409
Notices of Meetings	409
Precision Jig Drilling and Milling Machine (*Illus.*)	410
The Tinning of Piston Rings	410
The Future of Electricity Supply	411
The Earth's Heat Balance	412
Notes	413
The Iron and Steel Institute: Sheffield Meeting	414
Atmospheric Pollution	415
Planning the Post-War World	416
Adjustable Vacuum Relief Valve (*Illus.*)	417
Labour Notes	417
Ancient Harbours of the Mediterranean (*Illus.*)	418
Synthetic Rubbers	419
"ENGINEERING" Patent Record (*Illus.*)	419

One Two-Page Plate.—SOIL EROSION BY WIND ACTION IN THE UNITED STATES.

ENGINEERING

FRIDAY, NOVEMBER 22, 1940.

VOL. 150. No. 3906.

THE FUTURE OF ELECTRICITY SUPPLY.

THE second part of Mr. J. R. Beard's presidential address to the Institution of Electrical Engineers, an abridgment of which is continued on page 416 of this issue, appears, at first sight, to contradict the argument upon which the first part was based. This argument is that in planning the post-war world we must not make the mistakes that were made twenty years ago. In particular, we must do nothing which will sow the seeds of future conflict. In dealing with the future of electricity supply, however, Mr. Beard shows himself to be no iconoclast, and his proposals indicate rather that greater good will result from improving the present system than from "rubbing it all out and doing it again." The contradiction, however, is more apparent than real. In the first place, he nowhere argues that what is good in our existing organisation should be discarded. Secondly, in considering the future problems of electricity supply, he indicates that a certain change of outlook will be necessary, especially on the part of electrical engineers themselves.

To elucidate this point it is necessary to deal with the subject historically, as Mr. Beard does. The experiences of the last war showed the importance of planning generation for much more extensive areas and loads than was possible under the then existing "parochial" system. The result of this was the formation of the Electricity Commissioners, whose powers for good, however, were largely negatived by short-sighted legislative action and by opposition within the industry itself. The position with regard to generation was greatly improved by the establishment of the Central Electricity Board some fourteen years ago, but it is worthy of notice that the success of this body has been not a little due to the fact that, behind the tact and suavity with which its preliminary operations were conducted by Sir Andrew Duncan and Sir Archibald Page, lay powers by the exercise of which the recalcitrant could be brought into line. The national planning of generation, which has been one of the main operations of the Board, has been successful. *Inter alia*, it has resulted in the average cost of a kilowatt-hour being reduced to seven-eighths of what it would have been expected under unco-ordinated development. This reduction corresponds to an annual saving of about 9,000,000*l.*, all of which is being passed on to the ultimate consumer, though, unfortunately, its beneficial effect has been masked recently by the rise in the price of coal.

At the same time, the position cannot be considered perfect, and there are certain features in the organisation both of the Electricity Commission and of the Central Electricity Board which require attention with a view to improvement. These features are discussed in detail by Mr. Beard and may be studied, by those interested, in our abridgment of his address. In general, however, his suggestion is that the Commission should become more and more a body advising and guiding the Government on matters relating to electricity supply, on the one hand, and on the other, supervising the activities of the authorities in order to see that they carry out their duties in accordance with their powers. This would leave the authorities themselves wide freedom of planning and initiative in the operation and extension of their undertakings. In no direction would this freedom be more valuable than in the relationship which at present exists between the Commission and the Central Electricity Board. This relationship, it may be admitted, is the result of a praiseworthy caution; for it must be remembered that the Board, when it was formed, was a new and untried body and, though it has shown itself to combine in a marked degree the best features of both public and private ownership, it might not altogether have justified the hopes which its protagonists had for it. Actually, however, it has proved its value to an extraordinary degree, a result which is mainly due to its having been allowed to manage its finance and administration in comparative freedom from external control, to the small number of members comprising it, and to its non-political character.

Nevertheless, being an experiment, the Board has its weak points, and in particular its operations have been hampered in some degree by the restrictions which were placed upon its powers. For instance, it is prohibited from owning or operating generating stations save in very exceptional circumstances. It is placed under statutory obligations with regard to the price which it may charge owners of selected stations for their supplies; and it is subject to a considerable measure of technical control by the Electricity Commissioners, even in comparatively detailed matters. On the other hand, the owner of a selected station obtains no return for the use which the Board may make of his station in supplying energy to the grid. The Board, moreover, is only obliged to give a supply at one point in an undertaking's area, however extensive it may be, unless that undertaking has more than one selected station.

These restrictions have given a good deal of trouble, especially on the financial side, and it is becoming evident that, when peace is restored once more, legislation will be required to correct them. For instance, it is by no means certain that, for technical reasons, it will continue to be wise to prevent the Board from building its own generating stations; while, on the financial side, the tangle is so dense and complicated that it is only good will, and give and take by both parties, that has prevented something very like breakdown. Moreover, the time has surely come when the Board might be released from leading strings, and when greater flexibility with regard to the actual giving of supplies might be permitted, to the benefit of all parties.

Compared with the distribution side of the industry, however, generation is comparatively well organised, and it is to the former problem, therefore, that particular attention will have to be paid after the war. The distribution of electricity is, in fact, as Mr. Beard says, little better than a patchwork quilt; and this is the more deplorable since it is on this side that the supply industry comes most closely into contact with the consumer. From this very important person's point of view, the chief essentials are that he should be able to purchase electricity in the form he requires, whenever he wants it, at the cheapest possible price, and on a fair and simple basis. All these essentials could be met more efficiently than at present by a combina-

tion of national and regional planning, but, though ways and means of doing this were suggested in the McGowan report of five years ago, nothing has really been done. Unfortunately, one of the chief reasons for this inaction was the threat of considerable opposition from certain sections of the industry, though it should have been clear that matters could not have been left as they were.

A reorganisation of distribution on improved lines postulates standardisation of the system on which, and of the voltage at which, the electricity is supplied. As regards the former, the position is relatively satisfactory, since in 1937-38 the number of consumers taking alternating current was 8·24 millions, compared with only 1·12 millions who were supplied with direct current. Nevertheless, it is desirable that the complete elimination of direct-current supply should be achieved as quickly as possible. It is not unreasonable, therefore, that the supply of alternating current should be made compulsory after a limited period, even if some financial assistance is necessary to attain that end. Some determined movement towards the standardisation of voltage is equally important, if not more so. A standard of 230 volts for domestic consumers has long been agreed, and the only difficulty is the cost of standardising the non-standard systems, which amount to 78 per cent. of the whole. Formidable though this task may appear at first sight, it should not be more difficult than that of standardising the frequency; and its cost should not be more than about 75,000,000*l.*, a sum which it is well within the capacity of the industry to meet by some such levy as that now imposed to pay for frequency standardisation. The benefits to be expected should make this expenditure well worth while. At the same time, it must be remembered that, the longer the delay in initiating any scheme of this kind, the more costly it will be.

As regards availability of supply, the problem is how to shorten the period between providing facilities and the date when a remunerative return on the capital invested can be secured, both in rural areas and in the poorer parts of the towns. One remedy is the subsidising of such consumers in one or other way, as, in fact, is already done by the postal, transport and other services. Another is some form of compulsion under which a supply authority, unable or unwilling to meet its obligations in this respect, would be transferred to a larger and more energetic authority. Tied up with the question of availability is that of price, which, in turn, is associated with the advantages the consumer is likely to gain from large areas of supply. Technical developments can only bring about economy to a limited degree; further reductions in cost must be obtained by the application of rationalisation. In other words, experience shows that, generally speaking, a supply authority selling less than 20 million kWh per annum for domestic purposes cannot achieve the same economy as a larger undertaking. Some form of grouping appears to be indicated, therefore, combined with certain consequent modifications in the tenure of private undertakings. There remains the perennial and provocative question of the best form of tariff.

Enough has been said to show that electricity supply provides almost a surfeit of problems, both in number and in interest, to engage the attention of those whose responsibility it will be to deal with them. It is not too soon to start thinking about these matters. Unfortunately, the supply industry has a bad record for initiation. Its practice, too often, has been to wait until a scheme is suggested to it from the outside, and then to exhibit to the world, to use Mr. Beard's words, "a picture of diverse interests whose main concern seems to be the preservation of sectional rights and privileges." The history of events when both the 1919 and 1926 Acts were going through Parliament is an example of this mistaken procedure. It would be much better if, as he suggests, a small "Planning Council for Electricity Supply" could be formed by the different interests, the members of which would be given full authority to work out a mutually acceptable scheme, which could then be presented to the Government as a basis for legislation with the weight of the whole industry behind it.

THE EARTH'S HEAT BALANCE.

In recent weeks, we have recorded the delivery of three presidential addresses upon the general theme of the future and the need to make proper preparation for it. Before making plans for any great venture, however, it is very desirable to know what resources are likely to be available, and the relative degree of their availability; and to take stock of what has been accomplished in the past, in order that those resources may be employed economically as well as effectively. The urge to economise has been stressed during the past twenty years as it has never been before, at least, in the history of engineering, but, almost invariably, the motive has been purely financial. This has been particularly true in the case of fuels. When steam coal cost no more than 15*s.* or 18*s.* a ton, small coal for power-station boilers, some 11*s.* a ton, and petrol could be bought at 1*s.* or 1*s.* 2*d.* a gallon, the financial gain represented by an improvement of even 10 per cent. in the efficiency of energy conversion was regarded as hardly worth the trouble of securing. Not so many years earlier, ships leaving the Tyne in ballast for North American grain ports were using as ballast the duff coal for which no home market then existed, and were shovelling it overboard as they neared their destination, in readiness to begin loading as soon as possible.

Stress of circumstances, following the war of 1914-18, produced an urge for economy in the generation and use of power, which was intensified by the long years of industrial depression; but still the motive was primarily financial, and the interest that was taken in the subject by the technical institutions, as shown by the many papers dealing with one or another aspect of it, was usually whetted by some statement of cash equivalents by which the efficacy of the particular device or process could be gauged. It has been left to Professor A. C. G. Egerton, M.A., in his Thomas Hawksley Lecture on "Power and Combustion," delivered at the Institution of Mechanical Engineers on November 15, to indicate a motive for economy which hitherto has received much more attention from scientists than from engineers, by drawing up a "heat balance" for the earth and attempting with considerable success to show what energy is derived by the earth from the sun, how it is expended, and what is the duration of the resources on which civilisation, and life itself, depend.

It is not possible to refer here to more than a few main points from a lecture which was replete with interesting data and arresting deductions, but it may be said that, indirectly, Professor Egerton presented a stronger case for the continuance of every form of research into the utilisation of natural resources than any that we can recall in recent years. His figures were astronomical in magnitude, but his conclusions were clear-cut. Briefly summarised, his investigation showed that, of the $2{\cdot}3 \times 10^{14}$ horse-power reaching the earth in the form of solar radiation (about one 2,000-millionth of the total energy radiated by the sun), the effective input is of the order of $1{\cdot}3 \times 10^{14}$ h.p. The power dissipated by the tides he estimated at $1{\cdot}5 \times 10^{9}$ h.p., and that dissipated by lightning, from $1{\cdot}0 \times 10^{9}$ to $2{\cdot}0 \times 10^{9}$ h.p. A rough estimate of the power corresponding to the radiant energy assimilated by plant life is $3{\cdot}0 \times 10^{10}$ h.p. The power corresponding to the present rate of use of coal and oil he computed to represent a total of $2{\cdot}0 \times 10^{9}$ h.p.; and the estimated potential hydro-electric power, $3{\cdot}2 \times 10^{8}$ h.p.

The approximate world use of coal, petroleum and natural gas, according to Professor Egerton's figures, amounts, respectively, to 1,450 million, 276 million, and 55 million tons per annum; and he considered that, at this rate of consumption, the reserves readily available would probably not last for much more than a thousand years. In making this estimate, however, he did not refer to questions of cost, though he did suggest that difficulties would be experienced before that period was up. It seems likely that the expenditure involved in obtaining the coal and oil, and making them available at the places where they would be required, might have the effect of reducing the practicable duration of the supplies very materially, perhaps by half. The deficiency could hardly be made up from the wind, rivers, lightning and the tides, as is evident from the approximate figures which he quoted of the resources represented by these four natural forces. The suggestion that a remedy might be found through a closer understanding of the processes employed by the plant cell, aided by improved forestry and cultivation, visualises such an extensive programme of research and of subsequent practical application that little relief can be expected for some centuries; and the other possibilities of tapping the energy contained in the internal heat of the earth and in the atom appear at present to be even farther from realisation on a scale likely to affect the issue. Before any of these ameliorating influences could attain to a widespread effect, it is probable that the masses of the world's population would have attempted to reduce their own requirements of artificially-produced heat by migrating gradually to the warmer zones; but this would not diminish greatly their demand for industrial power, the rate of which may be expected to show a continued increase. It is problematical whether this increase can be offset by further improvements in the efficiency of energy conversion. Professor Egerton points out that, if coal had been burned in the power stations of Great Britain during 1937 at the same efficiency as in 1910, the consumption would have been 29 million tons instead of the actual total of 11 millions; but, obviously, there are limits to the possible continuance of such an improvement.

The whole tendency of modern industrial development has been to supersede manual labour by the machine, and this tendency is still strong. Nevertheless, Professor Egerton mentioned, it is computed that the total mechanical work performed in the world by the manual worker, his horses and his oxen, is not much less than the total amount of power generated by the burning of fuel and by water power. The energy output of the average human being is only one-twentieth of the energy represented by the food which he consumes, although one worker on the land can produce food enough for ten, taking the average productivity for Great Britain as a guide. From this it appears at first sight that there is sound reason for superseding manual labour in many branches of human activity, but in so far as this involves a more rapid consumption of irreplaceable reserves of fuel, its apparent economy may require to be reconsidered in the course of time. The wider use of the machine has been directed in the two main channels of improving the amenities of life and extending leisure. If the leisure is employed wastefully, that is, as an opportunity to dissipate still more the world's capital reserves of energy without producing any compensating advantage, it may become necessary to consider whether some limit should not be set to the permissible extent of mechanisation.

There are still many industrial operations which can be carried out more efficiently by hand than by mechanical means, although their nature does not preclude the possibility of designing machines for the purpose. The decision in such a case has been based hitherto purely on questions of monetary cost; but, unless some scientific advance releases the sources of energy which are yet virtually untapped, the time may come when decisions of this kind must be made on a basis of energy cost. This is taking a very long view ahead, admittedly, and rather portends a reversion to the mid-Victorian state of mind which insisted that leisure should be "usefully" employed. Modern opinion inclines to ridicule the interpretation which the mid-Victorian put upon the term "usefully," and itself tends to the hedonistic principle that "time which one enjoys wasting is not wasted time." There must be many, however, even to-day, who feel that man was meant for nobler ends than the mere pursuit of mass-produced and mechanised "pleasure," and who would welcome a wider appreciation of Professor Egerton's thesis that "in tilling the land, in riding the seas, there is happiness eternal"—and, it may be, a solution also to the problem of maintaining the energy balance of the earth for a few more thousand years.

NOTES.

The Thomas Hawksley Lecture.

The delivery of the Thomas Hawksley Lecture at the Institution of Mechanical Engineers has become, in recent years, an occasion on which the Institution avails itself of the specialised knowledge and ripe experience of men distinguished in other fields than engineering. This is as it should be, for, in spite of the allegations of narrowness of vision sometimes aimed at the engineer, he is usually capable of taking genuine interest in, and a broad view of, the structure of such sciences as, say, physics and chemistry; on which sciences, after all, his own work is fundamentally based. In the twenty-seventh Thomas Hawksley Lecture, delivered at the Institution on Friday, November 15, and entitled "Power and Combustion," Professor A. C. G. Egerton, M.A., Secretary to the Royal Society, dealt with his vast subject in such a manner as to bring vividly before his hearers the immense potentialities of those solar and derived terrestrial forces which man has only very partially exploited in some aspects, although, in others, he has used them, and continues to use them, in a reprehensibly wasteful manner. Since Professor Egerton is Professor of Chemical Technology at the Imperial College of Science and Technology, South Kensington, the part of his lecture dealing with combustion was handled perhaps in greater detail than the discussion on the sources of power, but both sections were presented in a factual and illuminating manner with, here and there, touches of philosophy, poetry and humour. We intend to print an abridgment of the lecture in forthcoming issues. The chair was occupied by the President of the Institution, Mr. Asa Binns, Wh.Ex. The appreciation of the audience was expressed by the vigorous acclamation, following the proposal of a vote of thanks by Mr. Loughnan Pendred, C.B.E., past-president, seconded by Dr. S. F. Dorey, Wh.Ex. As the meeting was held in the afternoon, for most members a part of the day otherwise earmarked, the attendance was not so large as is customary on such occasions, but Professor Egerton may rest assured that under more normal conditions the meeting hall would have been filled to capacity. The lecture is to be repeated before the Scottish Branch of the Institution at the Royal Technical College, Glasgow, on Thursday, December 5, at 7.30 p.m.; and before the North Eastern Branch at Neville Hall, Newcastle-on-Tyne, on the following day, at 6 p.m.

The Newcomen Society.

The annual general meeting of the Newcomen Society was held at the Iron and Steel Institute, on Wednesday, November 13. In the report of the Council for 1939-40, it was stated that 322 new members had been elected, most of whom were resident in America, and that the total membership on September 30, 1940, was 1,512, an increase of 260 on the previous year. Of these, 22 members are in enemy or enemy-occupied countries. Among the members who had died during the year were Mr. L. F. Loree, who is regarded as the founder of the United States branch of the Society; Mr. Summers Hunter, C.B.E., Mr. Samuel Vauclain, of Philadelphia, and Lieutenant J. J. Bootsgezel, of the Dutch Royal Navy, who lost his life on May 18, when escaping from the Netherlands during the invasion. Though two London meetings were cancelled through the stress of war, an interesting programme was carried through and the papers read will form a further attractive volume of *Transactions*. The *Newcomen Quarterly Bulletin* has been published regularly, thus enabling members to be kept informed of the Society's activities. The centenary of William Murdock (1754-1839) was commemorated by sending a chaplet to the Parish Church at Handsworth, Birmingham, where a memorial service was held; and the annual tribute to the memory of Thomas Newcomen was paid by sending a chaplet to Dartmouth, where it was placed on the Newcomen Memorial by the Mayor, on August 5. In co-operation with the Smeatonian Society, arrangements were made to erect a tablet on the chambers in Gray's Inn, London, which were occupied by Smeaton from 1783 to 1793; but the completion of the memorial has had to be deferred. At the meeting, Colonel C. E. Davies, the Secretary of the American Society of Mechanical Engineers, was re-elected president for a second year. After the conclusion of the formal business, two papers were presented. The first, entitled "Prehistoric and Primitive Iron Smelting: Part 2.—The Crucible Processes of the East," was contributed by Mr. E. W. Hulme. The second, by Dr. H. W. Dickinson, dealt with the bicentenary of Henry Cort.

The Electrical Industry and War Production.

In the inaugural address which he delivered to the North Eastern Centre of the Institution of Electrical Engineers, Mr. W. A. A. Burgess said that the electrical industry had been so well equipped with precision tools, skilled personnel and resourceful management that on the outbreak of war many of its factories had been able to turn over at once to the production of munitions and at the same time to satisfy the needs of the electricity supply branch, which had continued to expand. Much more assistance could, however, be given by all users of electrical equipment if they would utilise standard products wherever possible. Even to-day, a large number of special equipment was being called for by engineers who desired new and often revolutionary designs or modifications of standard products which were not justified either by engineering or economic development. Avoidable special development work, too, should not be imposed on staffs urgently required for output. An example was precision metering which, at the higher voltages and smaller loads, involved multi-turn current transformers and often special metallic stampings, the production of which was occupying the time of men and machines and was using not inconsiderable quantities of the rarer metals so urgently required in other directions. Manufacturers, moreover, often developed special fittings for some of their own products when a glance through another manufacturer's catalogue would provide them with a standard component that could be made to do everything required. The avoidance of such special and unremunerative work was as much war effort as something more spectacular. The Minister of Supply, Mr. Burgess said, should ration the production of normal manufactures for home consumption to the minimum and at the same time should assist factories to maintain a full load factor with such war products as could best be turned out. Both manufacturers and electricity supply authorities should ration themselves severely, as the most efficient way of reducing the demand for men and materials.

The Junior Institution of Engineers.

The 59th sessional general meeting of the Junior Institution of Engineers was held at the institution's rooms, 39, Victoria-street, Westminster, S.W.1, on Saturday, November 16, Mr. N. L. Ablett (vice-chairman) taking the chair in the absence of Dr. Herbert Chatley. In presenting the report of the Council, Mr. Ablett referred to the loss sustained by the Institution by the death of three past-presidents, namely, Colonel R. E. B. Crompton, Sir Joseph Thomson, and Mr. Freke Field. Mr. Field, a grandson of Joshua Field, F.R.S., the partner of Henry Maudslay, was the first president of the Institution. During the session, 140 new members and students were elected in the various grades, representing a net increase of 55. War-time conditions had affected the normal programme for the session, but a number of papers were read at the ordinary and informal meetings in London, and before the Midland, North-Western and Sheffield local sections. The report was duly adopted, as were the Annual Accounts, presented by the honorary treasurer, Mr. H. G. Pusey, which showed a surplus, on the year's working, of some 380*l*. After the other formal business had been concluded, the result was announced of the ballot for the election of officers and members of Council for the ensuing year. This showed the following to be elected: Chairman, Mr. J. W. Stenson; vice-chairmen, Mr. N. L. Ablett and Mr. L. P. Walter; hon. treasurer, Mr. H. G. Pusey; hon. editor, Dr. H. Chatley; hon. librarian, Mr. F. Squirrell; councillors, Messrs. R. Wailes, E. North, P. A. Cartwright and S. J. Moore; hon. auditors, Messrs. A. J. Brighty, H. M. Lees, E. H. Richmond, and A. J. Webb. Mr. Ablett then inducted Mr. J. W. Stenson as chairman of the institution. The annual general meeting of the Benevolent Fund of the institution was also held in the course of the afternoon, when an appeal was made by Mr. Ablett, on behalf of the committee of management, for a more general support of the Fund, in order that adequate reserves might be built up.

Training for Arms Production.

In a written reply to recent questions, the Minister of Labour (The Rt. Hon. Ernest Bevin) said that considerable progress had been made in training personnel for the production of munitions since the beginning of August. It had been clear on many occasions, he added, that this training must be done by the employers themselves, and full support for this procedure has been received from the Engineering Employers' Federation. Nevertheless, much more had still to be done to produce the trained labour required for the programme at which the Government was aiming and, though it was preferable to rely on the willing co-operation of employers there would be no hesitation in applying compulsion should this be found to be necessary in any particular case. The Ministry of Labour, for its part, was doing its utmost to assist in the training programme. During the last few months, ten new training centres had been opened and nine more would be opened very shortly. As far as possible, these centres were working on the shift system and the number of men now in training was three times as great as it was in May. Courses in engineering were also being developed in the technical colleges, where the numbers in training had been doubled since the beginning of September. In addition, arrangements were being made for training to be carried out by firms which were not engaged on the production of munitions. Finally, a scheme for training both men and women had been drawn up in agreement with the Engineering Employers' Federation and the Amalgamated Engineering Union. This provided for employers to train them on production, in excess of their own needs, for transfer to employment elsewhere for national use.

The Institute of Marine Engineers' Examinations.

We are informed by the secretary of the Institute of Marine Engineers that, as the Institute has now adopted the Common Preliminary Examination of the Engineering Joint Examination Board, admission to the Studentship grade, from October, 1940, will be open to those who (i) are at least seventeen and not over twenty-five years of age; (ii) have passed or obtained exemption from the Common Preliminary Examination above-mentioned; and (iii) have satisfied the Council that they are, or intend to become, engineering apprentices or engineering students at an approved educational institution. The former grade of Probationer Student is superseded by the new grade of Student, and the former grade of Student becomes the new grade of Graduate. Admission to Graduateship is open to those who (i) are between twenty and thirty years of age; (ii) have completed a recognised training in engineering or shipbuilding; and (iii) have passed Part A of the Institute's Associate-Membership Examination, or have attained an examination standard as prescribed by the Institute. Particulars of the exempting qualifications may be obtained on application to the Secretary, at 73, Amersham-road, High Wycombe, Buckinghamshire.

Electricity Supply in Eire.

A measure entitled the Electricity (Supply) Amendment Bill, 1940, recently received a second reading in the Dail. The main purpose of this bill is to provide an additional loan of 4,000,000*l*. to meet the capital requirements of the Electricity Supply Board for the next eighteen months. Of this sum, 800,000*l*. is to be allocated to the construction of a peat-fired generating station at Clonsast Bog, Portarlington; 60,000*l*. to increasing the transformer capacity at Ardnacrusha; 244,000*l*. to providing an additional 20,000-kW set, more modern switchgear and other improvements at the Pigeon House station, Dublin; 486,000*l*. to the

construction of a new 110-kW transmission system from Dublin to Cork via Waterford and from Carrick-on-Shannon to Dundalk, as well as substations at Waterford and Dundalk. A large expenditure on lower voltage transmission and distribution systems is also authorised and provision is made for existing undertakings to be purchased at the cost of 98,000*l*. Moreover, owing to the increase in the size of the generating plant originally budgeted for in the Liffey hydro-electric scheme and abnormal market conditions, further capital, amounting to 280,000*l*., is provided for this purpose. It is stated, for instance, that the cost of the dam has risen by 88,400*l*. to 320,450*l*., that of various new bridges by 79,000*l*. to 110,190*l*., and that of the mechanical equipment by 19,650*l*. to 38,190*l*. In introducing the Bill, Mr. MacEntee, Minister for Industry and Commerce, stated that the development of the Clonsast Bog would involve a minimum expenditure of 1,000,000*l*. He said it was estimated that its productive life was about twenty-five years, while that of adjacent bogs which could be developed was about the same. The ultimate value of the investment, however, depended on the success of the Turf Development Board in solving the very difficult problem of using at least 120,000 tons of fuel per annum. One particular difficulty was that of obtaining the necessary plant. He added that the time had now come when other new projects, in addition to those at Portarlington and Pontaphonea on the River Liffey, must be considered. The most important river from the hydro-electric point of view was the Erne, from which it was estimated some 160 million to 200 million kilowatt-hours could be obtained per annum. For this, the co-operation of the Northern Ireland authorities would be essential and would be warmly welcomed. It is believed that there is some prospect of this co-operation being forthcoming.

THE IRON AND STEEL INSTITUTE: SHEFFIELD MEETING.

The annual autumn meeting of the Iron and Steel Institute this year took the form of a joint gathering with the Sheffield Society of Engineers and Metallurgists and the Sheffield Metallurgical Association, and was held at the Grand Hotel, Sheffield, on Tuesday, November 12. The proceedings opened with a luncheon, which was followed by afternoon and evening sessions for the transaction of official business and the discussion of papers. The President, Mr. John Craig, C.B.E., occupied the chair, and there was a large attendance of members.

Opening Luncheon.

When proposing the toast of the Iron and Steel Institute and kindred societies at the luncheon, the Deputy Lord Mayor, Alderman J. A. Longden, J.P., laid stress on the value and benefit to industry of the research and experimental work carried out by these technical bodies. The President, in responding, said that the Institute had had considerable difficulty in arranging the present meeting. The times were not opportune for gatherings of this kind, although the need for such gatherings was as great as ever. Further, owing to the high reputation of its meetings, the Institute had been afraid to venture, in case it might be confronted with an element of failure to which it was not accustomed. The Council had felt, however, that, in Sheffield, the Institute could hold a joint meeting with the Sheffield Society of Engineers and Metallurgists and the Sheffield Metallurgical Association, and it was particularly indebted to Dr. W. H. Hatfield, F.R.S., its senior vice-president, in Sheffield, for acting as chairman of the committee of arrangements and making the meeting possible. Greater demands were now being made upon the steel industry than had been made upon it at any previous time in its history, and he thought it could claim an honoured place among this country's great industries for what it had done, for what it was seeking to do to-day, and for what he believed it would do in the future. In proposing the toast of the President, Dr. Hatfield said that he was very glad that Mr. Craig had been able to preside at the meeting because he thought that, although it was not possible to say much on the subject at the present moment, it would be recognised after the war that the Iron and Steel Institute, particularly through its various scientific and technical committees, had done well during the present critical period.

Afternoon Session.

The minutes of the previous meeting having been dealt with, the President referred to the great loss which the Institute had sustained by the recent death of two of its distinguished members, Sir Harold Carpenter, F.R.S., and Sir Robert Hadfield, Bt., F.R.S. They had both served as president, and, like many busy men, had found time to be most regular attendants at meetings of the Council and at the Institute's discussions.

Retiring Officers.

In accordance with by-law 10, the Secretary read a list of the names of officers who were due to retire, in rotation, at the next annual meeting. The list comprised three vice-presidents, namely, Mr. Arthur Dorman, Mr. J. S. Hollings, and Mr. C. E. Lloyd; and five members of the Council, namely, Captain H. Leighton Davies, Mr. I. F. L. Elliot, Principal C. A. Edwards, F.R.S., Mr. E. F. Law, and the Hon. R. G. Lyttelton. All these gentlemen were eligible for re-election. The Secretary also announced that Captain C. A. Ablett, O.B.E., who, a few years ago had presented a prize of 50*l*. for the best paper on steelworks engineering by a junior engineer, had now asked that the qualification be extended to apply to any engineer. As a result of this, the prize was now open for the best paper presented at the annual meeting on steelworks engineering.

Manufacture of Steel by the Perrin Process.

The first paper considered by the meeting was entitled "The Manufacture of Steel by the Perrin Process." It was by Mr. B. Yaneske, of the Chemical, Metallurgical and Research Department of The Tata Iron and Steel Company, Limited, Jamshedpur, India, and dealt with the experiments carried out prior to the final adoption of the Perrin process at Jamshedpur. In the absence of the author, a summary of the paper was given by Dr. T. Swinden. Mr. Yaneske's paper has been reprinted in our columns, the first instalment appearing on page 324 and the last on page 399, *ante*.

After presenting the paper, Dr. Swinden opened the discussion, stating that, to the best of his knowledge, the work done at Jamshedpur represented the first large-scale application, outside France, of the slag treatment process initiated by Mr. Perrin. The extent to which advantage could be taken of the process in this country, particularly in the present circumstances, required very careful consideration. Experiments were in fact being carried out by which it was possible that at least a partial application of the slag treatment method might be employed for irons which would not otherwise be suitable, for example, for acid-steel making, and the possibilities of its utilisation in the treatment of special irons for the foundry industry had not been overlooked.

Mr. J. H. Whiteley stated that the speed at which the reactions took place surprised him. For instance, within a minute the phosphorus could be reduced from 0·25 per cent. to 0·05 per cent. Those who employed the open-hearth method in steelworks were accustomed to much slower rates of reaction. It was well known that, in the Bessemer process, the nitrogen content of the steel increased, and he would like to know what was the nitrogen content of the steel made by the new method. The next speaker, Mr. R. Percival Smith, pointed out that the author had described the making of 100 casts at the Tata Company's works; in other words, he had given an account of a gigantic experiment, undertaken by a private company, in which 3,000 tons of steel had been produced. If one company could afford to do work of this type he wondered whether it would not be worth while for the steel industry, acting as a whole, to combine in trying to solve the many problems connected with open-hearth steelmaking. Mr. A. Robinson, who spoke next, stated that one very important point in the process was in connection with the melting of the slag. He would like to know whether a satisfactory furnace and a satisfactory lining for that furnace, capable of withstanding the action of the slag, had been found. It was well known in the steel industry that the material which damaged the banks and linings of furnaces was slag. He would also like to know the temperatures of the steel before and after treatment. The next speaker, Mr. J. Mitchell, stated that Mr. Whiteley had expressed surprise that the reactions took place so quickly but, after all, nearly 2 per cent. of phosphorus was removed in a little less than two minutes in a Bessemer converter. The moral of the paper appeared to be that, given the necessary intermixing with a suitable slag, almost any practical object could be attained. Mr. J. S. Gerber, who followed, stated that the Perrin process struck him as being somewhat similar to the Aston-Byers process and also to the "washing" process, employed in America long before the introduction of the Aston-Byers process.

Dr. W. H. Hatfield, F.R.S., said that Messrs. Thos. Firth and John Brown, Limited, had carried out a long series of trials on the Perrin process with the object, not of dephosphorising, but of obtaining a "cleaner" steel freer from inclusions. The steel made by the process had been quite good, but the outcome of the experiment had been that, while the process had not been condemned, it had not been adopted. If, however, his works had determined that their steel should be made by the Perrin process and had continued their experiments for months instead of weeks, no doubt the application of the process would have been improved. The cost of maintenance and the cost of running the slag furnace had an influence on the economics of the process. The President, in closing the discussion, remarked that the world was wanting better steel and, at the same time, the supply of good natural ores was decreasing. It appeared that the Perrin process might make the secondary ores of the world available for the production of high-grade steel. He believed that the steel industry would prosper best along individualistic lines coupled with a free exchange of information. He was not quite sure that a great national experimental college would ever attain the success which a man would secure who was trying hard to make good steel to beat a competitor.

Dr. T. Swinden, in a preliminary reply to the discussion, stated that in his own experience, the nitrogen content in acid Bessemer steel was normally of the order of 0·015 per cent. and this was not reduced unless the material was subjected to appreciable agitation. With the slag treatment, therefore, the nitrogen content would probably remain fairly high in the case of a low-carbon heat, but in some of the higher-carbon heats, in which fairly violent agitation took place, he would expect the nitrogen content to be somewhat reduced. Dr. Hatfield had mentioned the question of cost. He could not quote actual figures, but, clearly, the Tata Company anticipated a reduced cost of production as compared with that of its normal duplexing process. The anticipated saving was at least several shillings per ton. The furnace for slag melting certainly constituted a problem. In the new plant there were two slag-melting tilting furnaces, each of 50 tons slag capacity. They were of open-hearth design, were basic-lined and were heated with mixed gases. In the Aston-Byers process, an acid slag was employed and the object was to leave the slag in the metal and not to remove it; the washing process, on the other hand, was definitely on the lines of the Perrin dephosphorising process. He had been much impressed by the Perrin deoxidising process and had witnessed the treatment of 15 tons of highly-oxidised metal and the casting from it of 31 ingots, the first, middle and last ingots of which had been shown to be very clean and composed of really first-class steel. Nevertheless, he agreed with Dr. Hatfield that it was difficult to visualise the application of the process to its fullest extent unless plant were specially designed to carry out the work.

(*To be continued.*)

ATMOSPHERIC POLLUTION.

THE 25th annual report on "The Investigation of Atmospheric Pollution," which has been recently published by the Department of Scientific and Industrial Research,* contains all the available data on measurements for the year ended March 31, 1939. There is a brief report of the Standing Conference of Co-operating Bodies, 50 of which have appointed representatives to the Conference, made up of 43 municipal authorities, four industrial undertakings, and three other institutions. In addition to these, 33 municipal authorities and one industrial undertaking co-operate in the work. During the year, 51 co-operating bodies operated 128 deposit gauges, 16 automatic filters for measuring suspended sooty matter, 11 sets of apparatus for the estimation of sulphur by a volumetric method, and 47 for its estimation by the exposure of porcelain cylinders coated with a paste of lead peroxide.

In the report of the Superintendent of Observations, which deals with the measurement of pollution, the year under review is compared with (*a*) a figure termed the "General Average" for each place, obtained, when possible, by taking the average of the five years ended March 31, 1932, failing which, some other group of four or five years is taken; (*b*) the deposit during the previous year. The comparison is made by two separate methods:—The stations are divided into four groups or classes, termed, respectively, A, B, C and D, based on the quantity of deposit, A being the cleanest and D the dirtiest. These divisions are arbitrary and the basis of the classification is given in tabular form in the report. The actual classification is given in another table, which is summarised in Table I, on this page. The inferences to be drawn from this table for the different components into which the deposit is analysed are as follows:—Comparing 1938-39 with the general average, tar, carbonaceous matter, insoluble ash, and soluble loss on ignition, all show some improvement upon the general average; that is a larger percentage of stations are in class A during the year 1938-39 than in the general average. Soluble ash shows a slight decrease in the percentage of A stations, while "Total Solids," which summarises all the components, shows 25 per cent. of the stations in class A in the current year compared with 29 per cent. in the general average.

The second and more reliable method of comparison with past years, is based on a table of the mean monthly deposits at each place, which are expressed in another table as percentages of the general average for the different places. In Table II the total deposit from the air at a few places is given and the percentage which this is of the general average for each place is also given, thus showing whether there has been an increase or reduction. As small changes cannot be regarded as significant when making a comparison, it is assumed that unless the change exceeds 10 per cent. it cannot be regarded as indicating anything other than a chance alteration. These percentages are, therefore, examined and summarised in Table III, below. This table relates to 30 stations which had general average figures for the same five years, and it brings out clearly the trend of deposit for the two years 1937-38 and 1938-39 when compared with the general average. It also enables a comparison between these two years to be made. This comparison shows that in 1937-38 there was a general reduction of deposit, since a higher percentage of stations showed a reduction than an increase. The same remark applies to 1938-39 for all components of deposit except chlorine, for which 48 per cent. of the stations showed an increased deposit in 1938-39 against 22 per cent. with a reduced deposit. There is some indication that most of the chlorine in rain is derived from sea spray carried inland by the wind, so that variations in the chlorine content of the deposit may be due to changes of the wind direction and force.

If the amount of deposit at all stations for the year be compared with that of the general average, or with past years, a different result might be expected, since it is not quite the same as comparing the number of stations showing an increased or reduced deposit. From such a comparison it can be seen that the deposit of sooty matter has diminished considerably and that the year 1938-39 has the second lowest percentage of any year during the last twelve. The year of lowest soot deposit was 1932-33, with 86 per cent. of the general average, while the year under review has 87 per cent. The ash of the insoluble deposit was the lowest for the last twelve years, and showed a drop of 15 per cent. compared with the year before. The deposit of tarry matter has increased above the general average and of the twelve years, only three show a higher percentage of the general average. The five years 1928-33 had a low tar deposit, which suddenly increased in 1933-34 and has remained high since, with the exception of 1937-38. The total deposit was only 84 per cent. of the general average, an improvement of 3 per cent. over the previous year and the lowest of any year since 1927-28. This is very satisfactory, but it is to be feared that the improvement will not be maintained during the war years. It is of interest to remember that, since tar in deposit is mainly derived from the smoke of domestic fires, the cause of the increase in 1938-39 is to be looked for in connection with these. An exceptionally cold spell would, for example, explain the excessive amount of smoke.

A table giving the deposit of lime for each month is included in the report, and this shows that the highest for the year was in October, at Greenhithe, with 534 metric tons per 100 sq. km., or 21·6 per cent. of the total deposit. This is equivalent to 13·6 tons per square mile. The lowest lime deposit at Greenhithe in any month was 100 metric tons per 100 sq. km., or 2·55 tons per square mile. This high deposit at Greenhithe is attributed to the number of Portland-cement works in the neighbourhood. The deposit of lime shows no seasonal variations and ranges from 9 metric tons per 100 sq. km. at Southport (Hesketh Park), or 0·23 ton per square mile, to that at Greenhithe mentioned above.

At many of the observing stations, the *p*H value of the rainwater is measured and in discussing the results, a value of 5·5 is taken as neutral, this being the normal neutral value of 7 reduced by the presence of natural CO_2 in the air. A marked seasonal effect is evident in the *p*H value, the winter rainwater being more acid than that which falls in the summer, owing, of course, to the amount of sulphur released from winter fires. Some stations, such as those at Coventry and Leicester, show alkaline values during the whole year. Burnley, Halifax and Huddersfield, on the other hand, show acid conditions throughout the year, while at Liverpool, which has three stations, all the observations were acid with the exception of those for April, at Aigburth Vale, when a neutral value of 5·5 was reached. In London, the rainwater from October to March was nearly always acid. The acidity of the air was also estimated chemically, with results very similar to the above. The highest deposit found was 223 metric tons of sulphuric acid per 100 sq. km., during August, at Park Square, Leeds, this being equivalent to 5·69 tons per square mile. Leicester, Town Hall station, was not much below this, with 204 metric tons of sulphuric acid per 100 sq. km. in January, or 5·20 tons per square mile.

The amount of sooty impurities in suspension in the air is measured by means of automatic filters which draw the air through white filter paper, leaving a dark discoloration, the density of the discoloration being a measure of the soot in the air. The monthly averages given for eleven stations in the report for the years 1937-38 and 1938-39, indicate an improvement at some places and a deterioration at others, while some show no change. Greenwich gave the highest average concentration in 1938-39, ranging from 0·85 to 0·95 mg. per cubic metre from December to March. In winter, there is naturally more soot in the air than in summer, and the ratio winter/summer ranges from 1·22 at Edinburgh to 4·33 at Kew. In most places, it is of the order of 1·5. It is suggested that the high ratio at Kew is due to the fact that it is a residential district with a large number of domestic fires. The hourly variations show certain characteristics common to all stations, viz., low impurity in the early morning rising to a maximum in the forenoon, then a drop followed by a second, usually lower, maximum later in the evening, after which there is a rapid decline to midnight.

Expressing the number of days on which smoke, fog or haze occurred as percentages of the total days, showed that the highest percentage was at Greenwich, for which the figure was 56 per cent. The next highest figure was for Stoke, viz., 45 per cent., followed by Victoria-street, Westminster, with 34 per cent. Cardiff had no hazy days and Coventry only one. It is noteworthy that there appears to be a tendency for smoke fogs to be more frequent on Mondays, Tuesdays and Wednesdays than on other days; the lowest incidence occurs on Sundays.

Measurements of sulphur pollution were made at 16 places, by a volumetric method, and at 63 places by the exposure of lead-peroxide coated cylinders. The average sulphur-dioxide concentration ranged from 0·027 at Crossness to 0·134 at Westminster Bridge, the figures being parts per million. The highest figures recorded were 0·657 and 0·618 p.p.m. at Westminster Bridge and 0·531 p.p.m. at Greenwich, all in October. The highest figure recorded at Sheffield was 0·444 in January. The figures quoted are all averages over 24-hour periods. By the lead-peroxide method, a measure of the activity of the attack upon exposed surfaces is obtained and is recorded in milligrammes of SO_3 per hundred square centimetres per day, an arbitrary but convenient unit. The highest yearly average figure obtained was 4·28 at Sheffield (Deepcar), the next being 3·89 at Salford (Regent Road). The figure for London (Westminster Bridge) was 3·30. The lowest figures obtained were at Lymington and Totton, with a yearly average of 0·22, and Godalming with 0·25. The highest figure for any month, viz., 7·55, was obtained at Sheffield (Deepcar) in October. At Manchester (Monsall), there were five months with figures from 5·96 to 6·77.

TABLE I.

Classification Letter.	Insoluble Matter.						Soluble Matter.				Total Solids.	
	Tar.		Carbonaceous, other than Tar.		Ash.		Loss on Ignition.		Ash.			
	G.A.	1938-39.	G.A.	1938-39.	G.A.	1938-39.	G.A.	1938-39.	G.A.	1938-39.	G.A.	1938-39.
A .. .	11	18	30	35	42	47	1	7	35	33	29	25
B	57	57	69	64	58	52	89	84	64	67	70	75
C	25	24	1	1	0	1	9	9	1	0	1	0
D	7	1	0	0	0	0	1	0	0	0	0	0

TABLE II.

Station.	Total Solids Deposited (Mean Monthly).	
	English Tons per Sq. Mile.	Percentage of G.A.
Birmingham, West Heath ..	17·39	156
Bradford, Central	21·88	70
Cardiff	14·84	99
Edinburgh, Leith Links	14·10	94
Glasgow, Glasgow Cross	25·30	90
Halifax, Akroyd Park	18·69	147
Leeds, Hunslet	20·96	76
Leicester, Town Hall	22·85	79
Liverpool, St. George's Hall ..	29·38	105
London, Horseferry Road ..	30·42	103
Newcastle-upon-Tyne, Welbeck Reservoir	16·29	84
Sheffield, Attercliffe	31·19	123

TABLE III.

—	Per Cent. of Stations Showing—					
	Reduction of 10 per cent. or more below the G.A.		Increase of 10 per cent. or more above the G.A.		Changes less than 10 per cent. of the G.A.	
	1937-38.	1938-39.	1937-38.	1938-39.	1937-38.	1938-39.
Insoluble matter :—						
Tar	57	41	30	33	13	26
Carbonaceous, other than tar	39	54	42	14	19	32
Ash	52	75	22	11	26	14
Soluble matter :—						
Loss on ignition	58	61	6	29	36	10
Ash	78	68	3	7	19	25
Total solids	55	67	9	13	36	20
Included in soluble matter :—						
Sulphates	67	67	13	15	20	18
Chlorine	38	22	31	48	31	30
Ammonia	79	74	14	15	7	11

* H.M. Stationery Office. [Price 2*s.* 6*d.* net.]

PLANNING THE POST-WAR WORLD.*

By J. R. Beard, M.Sc.

(*Continued from page* 376.)

Applying the general principles given in the first part of the address† to the planning of those activities with which our members are specially concerned, I must restrict my suggestions to electricity supply, with which my work has been chiefly associated. There can be few who do not feel that some improvement in organisation is essential in the electricity supply industry, although there is naturally some divergence of opinion as to the form it should take. We should, however, make up our minds as to what should be done. We must not again, as has happened in the past, wait until a scheme is imposed upon us from outside and then exhibit to the world a picture of diverse interests whose main concern seems to be the preservation of sectional rights and privileges. To avoid this, a small Planning Council for Electricity Supply might be set up voluntarily by the industry itself on a representative basis, possibly with an independent chairman chosen by themselves, the members being vested by the different interests with full authority to hammer out a mutually acceptable scheme which could then be presented to the Government for any necessary legislative enactment. The members of such a council would, however, only reach an agreed scheme by a process of give and take; but surely it would be worth while to give freely to avoid allowing our future to become the sport of party politics and the experimental ground of doctrinaire enthusiasts. A well-considered scheme with the full weight of the electricity supply industry behind it could not be ignored by the Government and would probably be welcomed as a speedy means of settling one post-war problem.

From what I have already said it will be evident that I am not one of those who wish to see a vast nationalised organisation set up, but I recognise at the same time that certain aspects of electricity supply must be planned nationally if we are to secure the highest efficiency. I equally recognise that efficiency is not necessarily to be achieved by rigid ideas of ultra-uniformity and symmetry of structure or merely by magnitude of organisation. Even in the case of such services as the telephone and broadcasting, which are best organised on a national basis, some measure of decentralisation has been proved essential to efficiency. It will also have been clear that I am not one of those who feel that there is something fundamentally wrong in any trace of profit being retained in the provision of a public service, provided it is accompanied by adequate safeguards.

The criterion of the successful provision of any public service is that the consumer can get what he requires in quality and quantity at the lowest possible price. As electricity supply is a public service, which, if it is to be efficient, must be operated on a monopolistic basis, it follows that it must be subject to a substantial measure of supervision by the State in the interests of the public. The industry itself has tended more and more to fall into two parts, one dealing with generation and transmission in bulk and the other with the actual distribution to the ultimate consumers. It is therefore convenient to consider these two sections of the industry separately.

In establishing the Electricity Commissioners to promote, regulate and supervise electricity supply, the Government adopted a new technique of control. In place of a department of the Civil Service they set up an independent body which, though organised largely on civil service lines and responsible to the Minister of Transport, retains a certain measure of independence and is a direct charge on the industry it controls. This has resulted in placing on the Commissioners a certain obligation to consider the point of view of the industry in so far as this does not clash with the interests of the public. After more than 20 years' experience, it is desirable to review the powers and duties of the Commissioners in the light of the changed conditions which have developed.

The Commissioners are, and should remain, a technical judicial body entrusted with the oversight of the electrical requirements of the general public and of the relations of the activities of electrical undertakings with each other and with the community. Their duties would seem to be: (1) To advise and guide the Government on all legislation affecting the industry. (2) To ensure that, so far as reasonably practicable, electricity is available to all and at the lowest possible price. (3) To ensure that it is available in the form required, which, in general, means alternating current at 50 cycles per second at a standard voltage. (4) To ensure that it is supplied at a price which is fair as between different classes of consumer and on a form of tariff which is generally acceptable and understandable. (5) To impose regulations on electricity supply undertakings to ensure that in carrying out any works they do not create any undue danger or nuisance to the public. (6) To arbitrate between the public and the industry in all matters where it has been found essential for the Government to grant compulsory powers to supply authorities, so that the general good of the community shall not be hampered by unreasonable obstruction from sectional interests. This, in practice, means principally questions of wayleaves and the purchase of land. (7) To approve the forms of constitution and spheres of operation of supply authorities. The forms of constitution include all financial safeguards necessary for a continuing monopoly, such as the methods of raising capital, scale of depreciation and limitation of dividends. (8) To supervise the activities of such authorities in order to see that they carry out their duties in accordance with their powers. (9) To arbitrate on matters in dispute between supply authorities. (10) To record and study the results of the operations of the supply authorities and to make public comment on the efficiency of the services they perform. (11) To make grants for research and development in matters which are accepted as of general interest to the industry as a whole but which, for one reason or another, cannot conveniently be organised by the supply authorities themselves. These duties cover such a wide field and the Commissioners' powers of ultimate control are so great that it is most desirable that they should continue to leave to the various supply authorities wide freedom of planning and initiative in the operation and extension of their undertakings. Nevertheless, in any future planning of the industry it may be desirable that the interpretation of these duties should be clarified in certain respects, greater emphasis being placed on some than has been the case hitherto and, perhaps, less emphasis on certain others.

The experience of the 1914-1918 war also showed the importance, for reasons both of efficiency and also of security, of planning generation for much more extensive areas and loads than those of most of the existing supply authorities. Public opinion, however, was not ready for a wholesale transfer of an important section of an industry to public ownership, particularly as it would have had to be done in defiance of the general wishes of many of its leaders. The Commissioners found it impossible to carry out such a policy by voluntary means. From a purely technical standpoint this may have been unfortunate, but, looking back over the intervening years, it is evident that the technique of public ownership was then inadequately developed and that had bodies with compulsory powers been formed, their structure would have been clumsy and inefficient. It soon became evident that the efficiency of the industry was suffering to an increasing extent from the chaotic state of its generating methods and that some action was essential. The result was the formation of a Central Electricity Board to organise generation for the whole country. This was carried into effect by the 1926 Act, which forms a landmark in the development of all forms of public enterprise. It has given the country valuable guidance in working out what has, so far, proved to be the best constitution for a type of organisation which was increasing in number and importance before the war and is likely to play a still more important part in the future.

The Central Electricity Board has shown itself to combine in a marked degree the best features of both public and private ownership. This is mainly due to the Board having been allowed to manage its finance and administration in comparative freedom from external control, but an important contributing factor to the success which has been achieved is the personal one. Most previous bodies of this character had a large membership formed of representatives of all the numerous interests which were directly, or even indirectly, affected and the individual members frequently served for very limited periods. The Central Electricity Board, on the other hand, is a compact body of only eight members appointed for definite extensive periods and formed of members carefully chosen by the Government for specific qualifications of a completely non-political character. It is no doubt due to these reasons that the members of the Board have worked together in a true team spirit and, by remunerating the executive staff in a manner comparable with that current in industrial undertakings, have been able to draw on the highest administrative technical and commercial experience available.

It is not necessary to refer in detail to the activities of the Board and its technical achievements were dealt with very completely in Mr. Johnstone Wright's presidential address last year.* It is only necessary to give some consideration to certain specific points which must be borne in mind in any future planning of the industry. Certain important restrictions were placed on the Central Electricity Board's powers by the 1926 Act and, though some of these were relaxed by the 1935 Act, others require reconsideration in the light of experience. For instance, the Board is prohibited from owning or operating generating stations save in very exceptional circumstances. It is placed under a statutory obligation that the cost of electricity supplied by it in any year to any owner of a selected station shall not exceed what the cost of independent generation would have been had the Board not been in existence. Being a new and untried body the Board was, quite naturally, made subject to a considerable measure of technical control by the existing Electricity Commissioners, even on comparatively detailed matters. On the other hand, the Board were given certain powers which may also require reconsideration in the light of experience, of which two may be mentioned: If the owner of a selected station takes his supply from the Board on the basis of what it would have cost him under independent generation, he obtains no return for the use which the Board may make of his station for providing energy to the Grid, and the Board is only under obligation to give supply at a single point to any supply authority, however large and however extensive its area, except in so far as the supply authority may have more than one selected station.

As regards the changes which may be desirable in connection with each of these matters, in very few instances is the output of a generating station completely absorbed by its owner. It is provided and planned for a much wider area and may even, in certain circumstances, be giving supplies 50 to 100 miles away. The location of new generating plant is already planned by the Central Electricity Board, which is also responsible for repaying all operating costs—including capital charges—and for directing the method of operating the plant as regards both output and efficiency. The owner is therefore in the peculiar position of having no responsibility other than providing the capital—on excellent security—and providing the staff for designing and supervising construction and for operation. Hence, in most cases the owner is only an agent for the Board and gets no direct reward for his work. It may be asked whether, in these circumstances, it would not be better that the Board itself should own and operate all generating plant; if this were likely to result in appreciable economy, it should undoubtedly be done. Such a vast increase in the Board's responsibilities would, however, mean radical change and expansion of staff, would absorb a large amount of the Board's administrative and technical capacity, and would necessitate large regional sub-organisations which would have to be staffed and administered by the personnel of the existing supply authorities. It is therefore probable that any theoretical improvement in economy would be outweighed by the effects of the resulting dislocation and that the balance of advantage is in favour of retaining the present procedure.

There are, however, two modifications which are desirable. The Board might reasonably be required to make the owner some payment for the responsibilities imposed upon him. This could be in such a form as to give the owner a direct incentive to economy, both in capital and in operating costs. The procedure would require detailed consideration, but, as a basis, it might be possible to agree in advance the cost of production to be expected, divided into a fixed kilowatt charge and a unit charge, and to pay the owner a proportion of any saving effected during actual operation in either or both of these items. The Board itself should have power to build and operate a station at any point where it was technically desirable to place it, provided the Board could satisfy the Commissioners that the supply authority in whose area the station would be situated had not the experience and personnel to organise an undertaking of such magnitude. Some action in this direction has recently been taken, but only as a war-time measure.

(*To be continued.*)

* Inaugural Address to the Institution of Electrical Engineers, delivered in London on Thursday, October 24, 1940. Abridged.

† See page 375, *ante*.

* See Engineering, vol. 148, page 568, *et seq.* (1939).

American Colliery Industry.—The average daily production of bituminous coal in collieries in the United States, in the week ending October 19, was 1,368,000 tons, this figure being virtually the same as that for the preceding week. In the corresponding week of 1939, however, the average daily production was 1,742,000 tons.

Lantern Slides of Welding Repairs.—Messrs. Barimar, Limited, 14-18, Lamb's Conduit-street, London, W.C.1, have asked us to mention that they have available for loan a lecture and a series of lantern slides dealing with repairs, by welding, of damaged motor-car and machinery parts. Institutions, societies and technical colleges wishing to make use of them are asked to make early application to the firm.

ADJUSTABLE VACUUM RELIEF VALVE.

THE function of a pressure relief valve is self-evident but it is not perhaps so clear what duty the adjustable vacuum relief valve shown in Figs. 1 and 2, accompanying, is intended for. Briefly, the reason for its development by Messrs. B.E.N. Patents, Limited, High Wycombe, is that many firms employing vacuum vessels or receivers find it necessary to vary the degree of vacuum from time to time. Of course, an obvious method for such regulation is to fit a needle valve or external leak, which can be regulated by hand, on the pump or exhauster suction pipe, but, where the duties of the vessel are of an intermittent or variable nature, such a device requires frequent attention; some kind of automatic regulator is therefore desirable. The relief valve here described is automatic in action; if a higher degree of vacuum than is necessary exists in the receiver the valve opens and admits air until the vacuum is established at its correct value, at which point the valve closes. It can be adjusted to operate over a wide range.

The construction is very simple. From the external view, Fig. 1, it may be gathered that the body is formed from hexagonal bar stock and is turned down for part of its length, only sufficient of the original section being retained to enable a spanner to be used on it. From the section, Fig. 2, it will be clear that the hexagonal part is bored out to form a valve chamber with a raised seating and is screwed at the end to take a union, generally with a ¾-in. B.S.P.

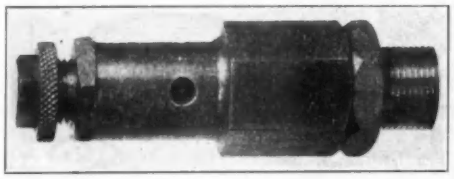
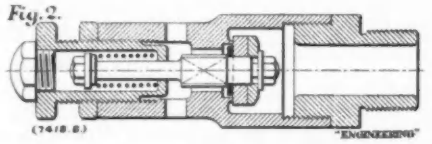


FIG. 1.

Fig. 2.



thread, the union being for coupling the valve to the vacuum vessel or pipe connected therewith. The turned end of the fitting is also bored to form an air admission chamber, while a hole in the division wall between this and the valve chamber makes a communication between them. The turned end is provided with a screwed cup-shaped plug with a locknut and sealing cap. This plug contains the spring which regulates the degree of pressure on the disc-valve. The admission chamber is drilled with four holes in its wall.

The disc-valve consists of an oil-resisting face of non-metallic composition held between a pair of discs and carried on the valve spindle, which is turned from square-section material, a portion being left square so that the slightly-rounded corners of the square centralise the spindle in the seating hole with the spaces between the flats and the wall of the hole providing the necessary air passages. The method of adjusting the compression of the spring which holds the disc valve on its seat will be clear from Fig. 2. The standard spring allows a range of adjustment of between 10 in. and 28 in. Hg. For settings under or over these limits special springs are necessary. The valve is very sensitive in operation and is readily adjusted to maintain the required degree of vacuum. Where the vacuum relief valve has to operate in an atmosphere laden with grit, dust or fumes, filters of felt or wire mesh should be arranged over the air-admission holes. The body of the valve is of gunmetal and the spring of phosphor-bronze, other parts being made of rust-proof materials also.

INSTITUTION OF NAVAL ARCHITECTS.—The secretary of the Institution of Naval Architects, 10, Upper Belgrave-street, London, S.W.1, informs us that, until further notice, no meetings of the Institution for the presentation and verbal discussion of papers will be held, and that only formal business will be transacted at the annual general meeting to be held on Wednesday, April 2, 1941. The Council, however, will be pleased to consider papers, or suggestions for papers, on subjects relating to naval architecture or marine engineering.

LABOUR NOTES.

IT is officially announced that the number of males registered at employment exchanges in Great Britain as wholly unemployed on October 14 was 333,936, a decrease of 9,443 compared with September 16. The corresponding figure for females was 301,495—an increase of 31,203. This increase was largely due to women seeking work in districts to which they had been evacuated. On October 14 there were 171,082 workers registered as on short time or otherwise temporarily suspended from work, a decrease of 13,918 compared with September. There were also on the registers 28,338 unemployed casual workers, a reduction of 2,837.

Between September 16 and October 14 the number of unemployed persons on the registers decreased by 23,617 in the London area, 204 in the North Midlands, 3,350 in the North-Western area, 1,607 in the Northern area, and 1,450 in Scotland. They increased by 6,885 in the Eastern area, 6,745 in the Southern area, 6,789 in the South-Western area, 2,466 in the Midlands, 4,899 in the North-Eastern area, and 1,450 in Wales. The Ministry of Labour and National Service, it is stated, has taken a count, and it has been found that 38,000 women and 11,000 men, included in the unemployment returns for the month, have been evacuated either compulsorily or voluntarily.

In October, the home branch membership of the Amalgamated Engineering Union increased from 437,264 to 445,214 and the Colonial branch membership from 39,113 to 39,758. The number of members in receipt of sick benefit increased from 4,186 to 4,314 and the number in receipt of superannuation decreased from 13,464 to 13,423. The number in receipt of donation benefit decreased from 520 to 470 and the total number of unemployed members from 2,502 to 2,352.

It is stated that at the recent conference between the Engineering and Allied Employers' National Federation and representatives of the engineering trade unions, a table giving a general picture of the wages position was submitted by the employers. In the case of the skilled classes of workers included in the statement the hours of work increased between October, 1939, and July, 1940, by 5·6 a week, and earnings went up by 28*s.* 1½*d.* a week. The hours of work of the semi-skilled classes also increased by 5·6 a week and earnings by 24*s.* a week, while the hours of the unskilled workers increased by 4·5 a week and earnings by 16*s.* 4*d.* a week. Fitters (skilled, other than toolroom fitters) working 58·3 hours, on time rates, earned 113*s.* 3*d.* in a test week in July; those working 59 hours on piece rates averaged 142*s.* 3*d.* a week. General average, 133*s.* 4*d.* Turners and machine-men rated at, or above, the fitter's rate, working 59·7 hours on time rates, earned 117*s.* 9*d.*, and those working 60 hours on piece rates earned 145*s.* General average, 138*s.* 1*d.* Men of the same classes rated below the fitter's rate worked 58 hours and earned 91*s.* 11*d.* on time rates; those on piece rates also worked 58 hours and earned 116*s.* 4*d.* General average, 111*s.* 6*d.*

Sheet-metal workers working 56·5 hours on time rates earned 110*s.* 5*d.* and similar workers working 56·7 hours on piece rates 147*s.* 8*d.*; general average, 141*s.* 6*d.* Moulders (loose pattern) working 54·3 hours on time rates earned 96*s.* 9*d.*, and similar workers working 52·3 hours on piece rates 114*s.* The general average was 105*s.* 5*d.* Platers, riveters and caulkers working 54·2 hours on time rates earned 98*s.* 8*d.*, and similar workers working 54·4 hours on piece rates 126*s.* 4*d.* The general average was 115*s.* 2*d.* Labourers working 58·9 hours on time rates earned 84*s.* 3*d.*, and labourers working 58·7 hours on piece rates 96*s.* 2*d.* The general average was 86*s.*

It was contended, on behalf of the employers, that under the existing conditions, the applications for wage increases, if granted, would not be in the interest of the country unless it could be shown that the granting of them was an imperative necessity, that the country could afford to pay, and that such payment would not represent an unreasonable balance in equity between engineering workers and other sections of the community, not forgetting the fighting men. Those in the engineering industry did not control a national wage policy, but what the industry did in respect of wages must have a profound effect on such policy.

Mr. Wilfred B. Beard has been elected general secretary of the United Patternworkers' Association and will take up office on January 1 next, when Mr. Allan Findlay, the present general secretary, retires. Mr. Beard is district secretary and organiser of the Association for the Lancashire and Cheshire area.

At a meeting in London last week with Sir Thomas Gardiner, Director-General of the Post Office, Mr. T. H. Boyd, the Assistant Director-General, and other members of the directorate, Mr. T. J. Hodgson, General Secretary, and members of the executive committee of the Union of Post Office Workers, gave details of the union's proposed plan for carrying on the postal service under air-raid conditions. The plan covers the whole field of postal, telegraph, and telephone services, and suggests that by making full use of daylight a reliable post office service can be provided. It also deals with the provision of proper protection for those workers—especially those in telephone exchanges—whose duties place them in the "front line" during raids.

Addressing the first of the series of conferences arranged for discussions of the Government's policy on "working after the siren" by representatives of employers and employees in munition centres—it took place in London last week—Mr. Herbert Morrison, Home Secretary and Minister for Home Security, said that the direct effect of German bombing on our vital factories must be considered a very poor return for the number of bombs and the number of 'plane hours which the enemy had expended. Figures collected by a well-known firm which supplied great quantities of constructional material for industrial buildings, showed that the orders received for material to replace that which had been damaged amounted to one-quarter of one per cent. of the material originally supplied. This was a fair and representative sample of the extent of the damage to the country's vast production scheme. But damage could be indirect as well as direct. If we allowed Hitler's bombers to drive us all to shelter every time they appeared he could paralyse our war production without dropping a single bomb.

From the two apparently conflicting claims of production and security there had been evolved, Mr. Morrison went on, the system of "Alarm within the 'Alert,'" under which the "Alert" would not be the signal for stopping work, nor the "Raiders past" the signal for resuming, but stoppage would be limited to the period in which bombers were close at hand and danger imminent. The initiative would be with each factory, and the ingenuity and practical knowledge of those on the spot would be given full scope in working out a system appropriate to their needs. The basis of the entire plan must be agreement between workpeople and the managements. "Why should the war worker be more interested in 'safety first' as a war-time motto than is his colleague of the Civil Defence force?" he asked. "Like A.R.P. workers and the fire services, the men and women in the arms factories are a voluntary army. Their discipline has no military sanction behind it, but is something they have shaped for themselves."

The conference was also addressed by Sir Alexander Ramsay, on behalf of the British Employers' Confederation; Mr. George Hicks, M.P., for the T.U.C.; and Air Marshal Sir Philip Joubert for the Royal Air Force. Explanations on the objects and working of the roof watcher system were given. It was decided to follow up the conference by appointing a joint committee, representative of employers and trade unions in the London area, to develop the system and arrange a series of local conferences.

According to an official account of a study carried out by the Division of Wage and Hour Statistics of the United States Bureau of Labour Statistics, an outstanding feature of the wage structure of the American iron and steel industry is the relatively small proportion of workers in the low-earning classes. Taking the skilled, semi-skilled and unskilled employees together, only a tenth (10·4 per cent.) received less than 62·5 cents per hour, and no more than 2·7 per cent. earned under 52·5 cents in April, 1938. By contrast, fully two-fifths (41·6 per cent.) of the iron and steel workers earned 82·5 cents or more, and the earnings of nearly one-fifth (18·8 per cent.) exceeded a dollar an hour. The overall average for all employees in April, 1938, was 83·9 cents per hour.

The results of another interesting study—it was carried out by the Bureau's Division of Industrial Accident Statistics—were given in a recent issue of the Labour Department's *Monthly Review*. It was stated that industrial injuries in the American iron and steel industry, as reflected in the experience of 1,861 departments with 842 million employee-hours in 1939, were somewhat better in 1939 than in 1938. Against 9·96 injuries per million hours worked in 1938, there were 9·71 in 1939. The total of disabling injuries in the group surveyed increased by 29 per cent., but the employee-hours worked increased by nearly 33 per cent.

ANCIENT HARBOURS OF THE MEDITERRANEAN.*

By Sir Leopold H. Savile, K.C.B.

(*Continued from page* 396.)

Tyre was another famous pre-Hellenic harbour, but it is only a few years ago that a true plan of its works was published by Père A. Poidebard. As a result of three years' research, from 1934 to 1936, in which he made brilliant use of aerial observation and photography, coupled with submarine observation and photography, Poidebard was able to demonstrate the incorrectness of all previous plans and the unreliability of any plan made of ancient works unchecked by careful research and observation on the spot. History has given the Phœnicians a reputation as builders and engineers. As builders they are, as everyone knows, renowned for the work they did for Solomon in building the temple of Jerusalem. Tyre had two harbours (Fig. 4), the Sidonian on the north of the island and the Egyptian on the south, and like Pharos, a spacious roadstead. The Sidonian was a closed (*kleistos*) harbour; that is to say, it was within the circumvallation of the city and its entrance could be blocked by suspending a chain from one side to the other. The Egyptian was an open (*aneimenos*) harbour, outside the fortifications but adjoining them. Tyre was a very old city, dating back, according to Herodotus, to 2750 B.C. This is probably incorrect, but at all events by 1400 B.C. its renown was widespread, and by 1100 B.C. its seamen had passed Gibraltar and had dared the Atlantic. It was probably about this time that the Sidonian harbour was built. Hiram, King of Tyre (970-936 B.C.), friend and ally of Solomon, was a great builder and engineer. When he came to the throne, Tyre was separated into three islands by arms of the sea full of reefs. Hiram filled these channels and on part of the land so reclaimed built the Egyptian harbour along its south coast. A massive mole, 2,500 ft. long, runs from the south-east corner to a large exposed rock lying off the south-west corner. Two similar moles, one running northwards from the rock at the end of the south mole, and the other running southwards from the shore of the island, enclosed the harbour on the west. The ends of these walls overlapped so as to form a protected entrance from the open sea to the western basin.

Two marked advances had occurred in constructional methods since the days when Pharos was built, namely the use of concrete in making sea-walls, and the use of iron dowels run in with lead. Both of these methods were used at Tyre. The moles had foundations of large, hewn, rectangular blocks, all laid as headers. The middle was composed of hard concrete, divided at intervals into compartments by transverse bonding. The side bordering the sea was faced with squared slabs, 10 ft. long by 4½ ft. thick, laid as stretchers. The south mole varied in width from 24 ft. to 26 ft., while the two western moles, which had to face the full force of the sea, were 7½ ft. wider. In the middle of the south mole was the main entrance to the harbour, and from each side of it two large wharves, built of concrete and faced with stone, were built across the interior for about two-thirds of its width. The narrow passage thus formed was commanded by a fortified post on the island. This passage was the boundary between the western and eastern basins.

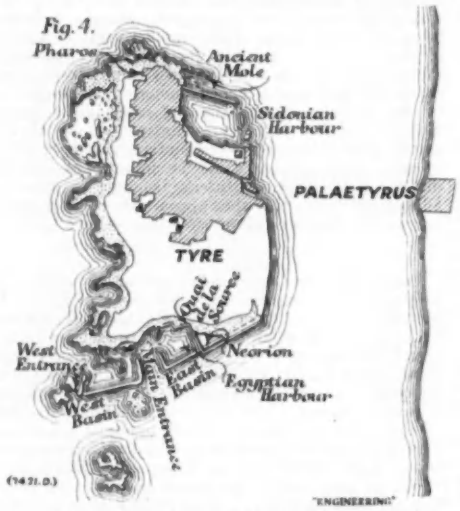
A concrete wharf cut the eastern basin into two, the farther and smaller one of which appears to have been paved throughout with flagstones and to have been used as a *neorion*, or shipbuilding and repairing yard equipped with slips and storehouses. Poidebard thinks that it may have communicated with its neighbouring basin by means of an inclined plane, but M. Bertou thought it had direct access to the sea. Possibly both methods existed. At the northern corner of the outer eastern basin was a small basin which accommodated a drinking-water tank for replenishing ships—an important item, for water was precious in Tyre, nearly the whole supply of the island having to be brought across by boat from springs on the mainland. The Sidonian harbour made use of a small bay at the north-east side of the island and was partly surrounded by the city. Two jetties, one jutting out from the ancient tower near the modern lighthouse and the other coming from the opposite side in a northerly direction to meet it, protected its entrance.

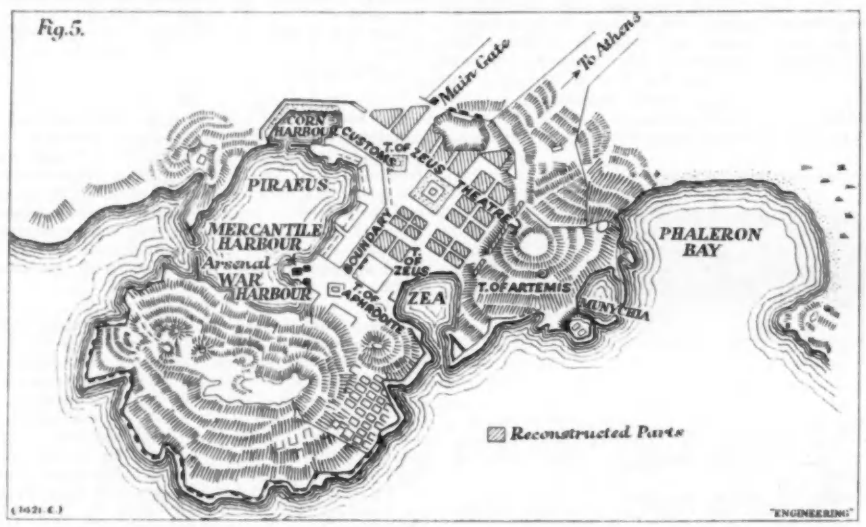
Old authorities record that the two harbours were connected by a canal, and many old plans show this canal, but it is not shown on Père Poidebard's plan, or on Berthou's, made in 1846. It is, however, possible that there was communication. It was a common custom in ancient harbours to have two separate, but interconnected, basins, and Sidon was laid out on this plan, which had obvious advantages. Vessels could enter one of the basins when a contrary wind prevented them from entering the other; if one basin were made unsafe by a storm, ships could move through the canal and take refuge in its neighbour; while if an enemy attacked he would have to split up his fleet or risk being surprised by the defenders who, having escaped through the other entrance, might attack him in the rear.

In addition to its harbours, Tyre took care to protect its roadsteads. North and south of the island, ridges of rock, partly submerged and partly exposed, stretched parallel to the coast and formed a natural barrier against the waves. That they were not, however, considered sufficiently effective has been made clear by Père Poidebard's discovery of traces of two separate lengths of wall based on the southern line of reefs, one about 1,000 ft. and the other 1,650 ft. in length. These walls were of massive structure, 100 ft. wide, and were faced with rocks, some of which were 10 ft. square by 2½ ft. thick, and weighed about 15 tons. Probably, although sufficient evidence is not yet available, there was a similar reinforcement of the north reef. The stone used is different from the rocks upon which it is laid, and it must have come from quarries on the mainland where a similar stone is found. One cannot help wishing that more information were available as to how these immense masses of stone were conveyed to the spot and laid with such accuracy. Tyre enjoyed many centuries of fame as the finest and richest city in the world. All will recall the three vivid chapters in which the prophet Ezekiel describes the city and foretells its fall. Even in the bitterness of his scorn he cannot refrain from a note of admiration: "by thy wisdom and by thine understanding thou hast gotten these things."

Five hundred and eighty years after the death of Hiram came Alexander the Great. Tyre, unconquered still, was too great a danger to leave behind him while he was away subduing the East. Alexander's fleet was too weak to fight her at sea. Nothing daunted, he attacked from the land, and for this purpose he built a colossal mole, 100 ft. wide and ¼-mile long, in 3 fathoms of water, so that Tyre ceased to be an island and became a peninsula. He demolished the old city of Palætyrus for stone and robbed the forests of Lebanon for timber to accomplish his purpose. In nine months he completed his task and captured the city. The laws of nature asserted themselves; coastal drift completed what Alexander began, and now Sur, the ancient Tyre, is connected to Syria by a broad neck of land.

The following interesting example will illustrate the efficiency of the ancient harbour engineer. Some years ago a friend of mine went out to advise on the construction of a harbour in the Black Sea. After careful study, he recommended a plan for a rubble stone breakwater protecting a deep-water pier. On his return journey his ship called at Samsoun, the ancient colony of Amisus. As he had never been at Samsoun before, he went ashore to look around, and was interested to find the ruins of a rubble breakwater sheltering a massive quay-wall, made of great blocks of masonry, which might almost have been built to the plans he had just drawn up. The ruins dated back to the days of Darius, say, about 500 B.C., and I am very tempted to see in them the "wisdom and understanding" of a Tyrian engineer, for it is known that the Phœnician interests extended thus far.





When we come to Grecian times, a rather different state of things is found. The shores of Greece and those of most of her colonies abounded in deep bays and long arms of the sea stretching inland, forming excellent natural harbours that required little in the way of artificial works to make them safe refuges. Great harbours of cyclopic stonework like Pharos and Tyre were, therefore, unnecessary. Generally, all that their natural harbours needed, apart from quays and wharves, were short moles to narrow the entrance. In the early days, Athens used the broad open bay of Phalerum, where ships were beached in sight of the city. That arrangement had several disadvantages. In a surprise attack the enemy might land and paralyse the defenders before they could get down from the city and launch their ships; a more serious and permanent objection was that vessels had to lie out in the open exposed to the elements, an important fact when it is remembered that no voyages were undertaken between November and March. When the Persian danger arose, Themistocles, in 493 B.C., persuaded the Athenians to transfer their shipping to the fine natural harbour of Piræus and its two small neighbouring land-locked bays of Zea and Munychia (Fig. 5). The works initiated by Themistocles and completed by Pericles, gave Athens one of the safest and most convenient harbours in the ancient world. All three harbours were enclosed in one circuit of fortifications and connected to the city by the two famous long walls. The natural entrances to Piræus and Munychia were reduced in width to 55 yards and 40 yards, respectively, by the construction of solid breakwaters. Zea needed no narrowing. Apparently those breakwaters were constructed by heavy rubble thrown into the water and allowed to assume a natural slope. When the mound thus formed reached water-level, a superstructure of huge blocks, some of them 10 ft., square, fastened together with iron cramps, run in with molten lead, was built. This was the usual type of Grecian pier. Piræus, the main harbour, was divided into three chief basins, the mercantile harbour, in the centre, which occupied most of the area, the small corn harbour on the north, and the war harbour in the south. In the centre was the *agora*, or market, of Hoppodamus; on the western margin of the War Harbour (the *Kantharos*) extended the emporium or *deigma*, flanked by a series of porticos, the centre of commercial activities; near the entrance to the corn

* Presidential address to the Institution of Civil Engineers, delivered in London on Tuesday, November 5, 1940. Abridged.

harbour was another large *agora*. Around the three harbours shipsteads were built, in which vessels could lie high and dry. They formed an essential part of the dockyard, especially for warships, which put to sea only on active service. If the triremes were left lying in the water they soon became leaky and unseaworthy, and also were liable to be attacked by the *teredo*. Their wooden fittings were stored alongside the vessels in the shipsteads; hanging tackle, sails, and ropes were kept in the large arsenal at the entrance to the War Harbour. Traces of such buildings in Zea and Munychia are still in existence; those around Zea were roofed by low gables supported on stone columns, each gable sheltering two triremes.

Piræus, Zea, and Munychia were typical examples of the Greek natural harbours. At some places, however, artificial harbours had to be constructed of which that at Eleusis may be regarded as typical. Two breakwaters were built out from the shore, curving inwards to form a narrow entrance between their ends. Within the harbour was a jetty. This jetty and the breakwater were constructed in the same way, with a foundation of dumped stone and a superstructure of large blocks held together by iron dowels. In all cases the material used was stone, probably because the art of pile-driving was not yet sufficiently developed to make the use of piles safe in harbour engineering.

(To be continued.)

SYNTHETIC RUBBERS.*

By LAWRENCE A. WOOD.

(Concluded from page 356.)

THE higher cost of synthetic rubbers is offset in a number of cases by the superiority of some of their properties in comparison with those of natural rubber. Foremost among these properties at present is resistance to the effects of liquids, particularly petroleum products. Table VII, on this page, presents the results of swelling measurements for natural and synthetic rubbers in a number of liquids in which the swelling of natural rubber is particularly large. The figures have, in some cases, been rounded off from those actually observed. Since the data were necessarily obtained from a number of sources, the values, like those for tensile strength, may not be strictly comparable in all cases.

The first eight liquids are petroleum products, in the handling of which synthetic rubber has been found particularly useful. Unfortunately, the common names used for the liquids are insufficient to describe their chemical compositions, which may vary widely with place of origin and subsequent treatment. Since the swelling is determined largely by the chemical composition of the liquid, such a wide variation of values is obtained that the figures quoted for these products are less significant than those for the others. Neoprene, for example, may swell in different lubricating oils at 100 deg. C. as much as 120 per cent. or as little as 12 per cent. Correlation is found with a figure which represents to some extent the ratio of aliphatic to aromatic constituents in the oil. For many uses, loss of tensile strength on swelling is an even more serious factor than the actual swelling. Very little information on this subject has been published. Usually, the tensile strength of a synthetic rubber shows less impairment than that of natural rubber, even when the amounts of swelling are not widely different. Synthetic compounds can be made which are greatly superior to natural rubber in that there is much less extraction of soluble material by liquids in contact with them.

TABLE VII.—SWELLING OF VULCANISED COMPOUNDS IN LIQUIDS.

(Volume increase, per cent., after immersion for 8 weeks at room temperature.)

Liquids.	Natural Rubber.	Neoprene.	Perbunan.	Perbunan Extra.	Thiokol A.	Thiokol D.	Thiokol DX, F.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Light gasoline (benzine) ..	160	—	20	20	0	—	—
Gasoline	230	8	40	—	0	3	3
Kerosine	—	60	—	—	0	2	2
Diesel oil	120	—	15	15	—	—	—
Fuel oil	—	—	—	—	0	10	10
Lubricating oil	—	40	−4	—	0	1	1
Paraffin oil	140	—	3	—	—	—	—
Transformer oil	150	—	5	—	—	—	—
Acetone	—	25	110	100	—	—	9
Benzene	370	160	210	140	7	150	90
Carbon tetrachloride	670	160	220	120	0	40	30
Ethyl ether	130	50	50	—	—	—	—
Linseed oil	100	—	20	—	—	1	1
Turpentine	300	90	50	30	0	—	—

The second important general superiority of many synthetic rubber compounds is their resistance to deterioration or ageing under conditions which impair the utility of natural rubber. Some of these conditions are exposure to the oxygen of the atmosphere, to ozone from electric discharges, or to light, especially direct sunlight, or to high temperatures. Flex-cracking can also be considerably reduced or eliminated in many cases. Since the usual deterioration of natural rubber is thought to be connected with an oxidation reaction involving the double bonds, it is not surprising to note the superiority, in this regard, of isobutene polymers and plasticised vinyl chloride polymers, which contain no double bonds.

Synthetic rubber compounds can be made which show a greatly decreased permeability to liquids and gases as compared with natural rubber. Part of the advantage is due to the absence of proteins and other nonhydrocarbon constituents, and part to differences in structure. The diffusion constant for water is defined by Taylor, Herrmann, and Kemp as the number of grammes of water vapour passing through 1 sq. cm. of the material 1 cm. thick in 1 hour, under a differential pressure of 1 mm. of mercury. The values which they found are as follows:

Soft vulcanised rubber	$6{\cdot}66 \times 10^{-6}$ g.hr.$^{-1}$ cm.$\cdot$cm.$^{-2}$ (mm. of mercury)$^{-1}$
Evonite	$1{\cdot}51 \times 10^{-9}$ g. hr.$^{-1}$ cm.$\cdot$cm.$^{-2}$ (mm. of mercury)$^{-1}$
Neoprene, vulcanised	$2{\cdot}63 \times 10^{-8}$ g. hr.$^{-1}$ cm.$\cdot$cm.$^{-2}$ (mm. of mercury)$^{-1}$
Thiokol A	$0{\cdot}22 \times 10^{-6}$ g. hr.$^{-1}$ cm.$\cdot$cm.$^{-2}$ (mm. of mercury)$^{-1}$
Plasticised vinyl chloride polymer	$3{\cdot}85 \times 10^{-8}$ g. hr.$^{-1}$ cm.$\cdot$cm.$^{-2}$ (mm. of mercury)$^{-1}$

Roelig has given corresponding figures for the Buna rubbers. Buna SS has a lower permeability than natural rubber, especially when the unvulcanised materials are compared.

The permeability to gases of several types of synthetic rubber has been measured by Sager and Sucher, by Sager, and by Barrer. "Permeability" is defined by the former observers as the number of cubic centimetres per minute passing through a membrane 1 cm. thick and 1 sq. cm. in cross-sectional area, when it separates air at atmospheric pressure from the gas at a pressure of 30 mm. of water above atmospheric. The mean values which they obtained for hydrogen at 25 deg. C. are as follows: Rubber, 24×10^{-6} cm.^{3} $\cdot$ min.$^{-1}$. cm. $\cdot$ cm.$^{-2}$; Neoprene, $4{\cdot}2 \times 10^{-5}$ cm.$^3 \cdot$ min.$^{-1}$. cm. $\cdot$ cm.$^{-2}$; Thiokol B, $0{\cdot}71 \times 10^{-6}$ cm.$^3 \cdot$ min.$^{-1}$. cm. $\cdot$ cm.$^{-2}$; and Thiokol D, $1{\cdot}5 \times 10^{-6}$ cm.^{3}. min.$^{-1} \cdot$ cm. $\cdot$ cm.$^{-2}$. Buna S, Buna 85, and Buna 115 possess about the same permeabilities to air as natural rubber does, but Perbunan vulcanisates show a permeability less than half as large. Since a very appreciable fraction of the weight of Neoprene and Koroseal consists of chlorine, these materials show a greater resistance to burning than natural rubber. They burn when a flame is applied, but combustion usually ceases when the flame is removed.

Losses from abrasion measured in the laboratory are reported to be about the same for the best compounds of Buna 85 and Buna 115 as for a high-grade tyre tread of natural rubber. With Buna S, the abrasion is said to be about 25 per cent. less and with Perbunan about 40 per cent. less. The figures refer to a material containing no softener or plasticiser. With the addition of the plasticisers which are necessary for working the materials on ordinary rubber machinery, as is done in the manufacture of tyres on a plant scale, the advantages in resistance to abrasion are considerably reduced. It is stated that road rests in which 40 test cars travelled about 750,000 miles, showed losses from abrasion for tyres of Buna S and Perbunan to be about 10 per cent. less and about 30 per cent. less, respectively, than for tyres of natural rubber. More recently, the figure of 25 to 35 per cent. has been given as the result of a long series of road tests on tyres of Buna S. The other varieties of synthetic rubber are either inferior to natural rubber in resistance to abrasion, or only slightly superior. The absorption of energy by synthetic rubber during repeated stresses is generally greater than that for natural rubber. This quality, a disadvantage under many conditions, especially where it may lead to overheating of the rubber as in tyres, is desirable in cases where the rapid damping of vibrations is important.

As has been already mentioned, emulsion polymerisation yields a latex similar to that of natural rubber. The latices of Neoprene and Buna S contain particles which are smaller than those in the latex of natural rubber and are more nearly uniform in size. Furthermore, they contain no organic impurities subject to putrefaction through bacterial action. Consequently, they are often used where the penetration of the latex into fine pores is of importance or where decomposition must be avoided. The latex of Thiokol A contains particles larger than those of natural rubber.

The electrical properties of some types of synthetic rubber, notably Vistanex and Buna S, may be superior to those of natural rubber. The presence of polar groups, as already mentioned, is responsible for relatively high values of conductivity in Neoprene, Perbunan, and Koroseal. This property may sometimes be turned to advantage, as, for example, in the dissipation of undesired static charges.

The applications of synthetic rubbers, like those of natural rubber, are so many and varied that it is impossible to do more than list some of the general fields and to illustrate with a few specific examples. In general, there are possibilities for the use of synthetic rubber in every application of natural rubber and in a number of additional fields from which natural rubber is barred by some of its deficiencies. No single type of synthetic rubber possesses outstanding advantages in all fields. However, for any given application it is usually possible to select a particular variety of synthetic rubber which excels natural rubber in some property of importance for that application. Possibly no individual synthetic rubber will ever have as wide a field of application as natural rubber, but collectively synthetic rubbers possess a marked advantage over natural rubber by reason of the diversity of properties which they afford.

The commercial applications of synthetic rubber throughout the world to-day are determined in part by considerations of national economy and in part by those of the inherent characteristics of the different varieties. More natural rubber is used in vehicle tyres and tubes than in any other single field of application. Where considerations of national economy enter, notably in Germany and in Russia, synthetic rubber is used very extensively for this purpose. Elsewhere, however, its higher cost has thus far prevented anything more than experimental applications in this field, where the deficiencies of natural rubber are not particularly noticeable.

Buna S is at present the type of synthetic rubber in general use in Germany for tyres, while Perbunan is generally reserved for those uses where resistance to the effects of liquids is important. There are several important factors dictating the choice of Buna S rather than Perbunan for tyres. It is cheaper to produce, and plasticisation with hot air is possible. In adhesive properties Buna S is superior to Perbunan, although still inferior to natural rubber. Natural rubber, because of its greater adhesiveness and small energy absorption, is sometimes used for the carcases of a tyre in which Buna S is used for the tread. A direct bonding between the two, without the use of intermediate material, is possible, but direct bonding is impossible between Perbunan and natural rubber. The lack of sufficient adhesiveness leads to difficulties in building tyres with a large number of plies without the use of natural rubber. The manufacture of 4-ply and 6-ply passenger-car tyres exclusively from Buna S is said to be on a satisfactory basis, but some problems connected with the manufacture of heavy truck tyres apparently have not yet been completely solved.

Each of the properties in which synthetic rubbers may be superior to natural rubber suggests possible applications for the former. Resistance to the effects of liquids, particularly hydrocarbons, is responsible for the very extensive use of synthetic rubber in hose and tubing, especially in the handling of petroleum products. In oil fields, refineries, tankers, filling stations, and in the automobile itself, petroleum products now usually pass through hose and tubing of synthetic rubber and into tanks which are sealed with it. Elsewhere in the automobile are many other parts which may come in contact with oil. More of them every year are being made of synthetic rubber or jacketed with it. The number of such parts at present on some cars is said to be as high as 30 or 40. For use in contact with oils, grease, fats, and many chemicals, mountings for vibration absorption, conveyor belts

* *Synthetic Rubbers: A Review of Their Compositions, Properties and Uses.* Circular C 427 of the United States National Bureau of Standards. Washington, D.C.: The Superintendent of Documents. [Price 10 cents.] Abridged.

tyres for industrial trucks, gaskets, and sealing devices are being made of synthetic rubber. Additional examples are shoe soles and heels, aprons, gloves, and similar articles for use under the same conditions. The relative stability of synthetic rubbers towards liquids is responsible for their increasing use in printers' rolls and blankets, engraving plates, and similar articles. Tubes for spraying equipment for paints and lacquers utilise synthetic rubber to advantage. Neoprene, Thiokol, and Koroseal are extensively used in these applications.

The electrical uses of synthetic rubber deserve special mention. As already noted, Vistanex, Buna S, and the numbered Bunas are the only varieties which show superiorities to natural rubber in respect of purely electrical properties. They are being used as insulation for wires and cables. For many uses, especially at low voltages, the other varieties, such as Neoprene, Thiokol, and Koroseal, may be used also for insulation. There is much wider application, however, of these other varieties as jackets over insulation of natural rubber. They are frequently used in this way to protect natural rubber from the effects of light, air, ozone, oils, and other deteriorating influences. In many types of cables, jackets of synthetic rubber are displacing the lead sheaths formerly used.

The properties of low permeability to gases and stability in direct sunlight have been responsible for the use of synthetic rubber in balloons, from small ones intended for meteorological observations to large passenger-carrying dirigibles. For example, the Goodyear airship Resolute, used for sightseeing flights, is covered with fabric coated with Neoprene. The impregnation of silk, cotton, and other fabrics with synthetic rubber, of better ageing qualities than the natural, opens up a whole field of household and personal uses. A few examples of products of this type are umbrellas, raincoats, tablecloths, shower curtains, and garment bags. Koroseal, which can be obtained in an extremely wide variety of colours, is especially applicable in this field.

The steady increase in production of each type of synthetic rubber has been accompanied in general by a decrease in price. Many types are still produced in such small quantities that an expanded scale of operations may yet bring drastic reductions in price. In Germany and Russia, the only foreign countries where significant amounts of synthetic rubber are being produced, political considerations enter into reports of production figures, and the controlled economy of these countries makes it almost impossible to compare costs with those elsewhere. Even when market prices are known, the foreign-exchange situation of these countries renders impossible a really significant calculation for the conversion of currencies.

In Germany, a plant at Schkopau with a capacity of 25,000 tons a year began production in April, 1939. Another at Huls, Westphalia, of the same capacity, has been under construction, and is probably now in operation. Recent Russian figures are not available, but estimates as high as 50,000 tons a year or more are not uncommon. Compared with these figures for the countries where synthetic rubber is used in tyres, the production figures seem very small for the United States, where such is not the case. The total production of synthetic rubber of all types in the United States in 1939 probably did not exceed 2,500 tons. Neoprene and Thiokol have been produced in far larger quantities than the other types.

The present market price of Neoprene is from 65 cents to 75 cents per lb., depending on the variety; that of Thiokol is from 35 cents to 60 cents per lb.; that of Vistanex is from about 60 cents to a dollar per lb. Koroseal is not sold on the open market, but its price is estimated as being of the order of 50 cents or 60 cents per lb. The cost of the Buna rubbers has been stated to be less than four times the cost of the natural rubber. Perbunan has been sold in the United States at about a dollar per lb., a figure in general agreement with this statement. The cost has probably been somewhat reduced by the recent very extensive expansion of production facilities.

Open-Hearth Furnace at Kembla, Australia.—Some interesting details regarding the construction of a 250-ton open-hearth furnace, put into commission at the Kembla Steel Works of Australian Iron and Steel, Limited, in January, 1940, are given in a recent issue of the *Broken Hill Proprietary Review*. The hearth of the furnace is made up of magnesite bricks and the roof is built up of silica bricks. In order to prevent damage to the roof owing to overheating, a carborundum "target block" has been placed in the centre of the roof and automatic roof-temperature control has been installed. This equipment cuts off the supply of fuel when the roof temperature reaches 2,950 deg. F., and turns it on again after the temperature has dropped by 20 deg. F. The furnace is stated to be giving completely satisfactory service and to have produced up to 2,963 tons of steel in a week.

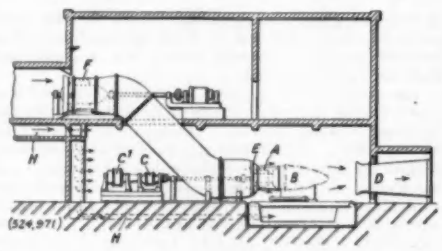
"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.
Where inventions are communicated from abroad, the Names, etc., of the communicators are given in italics.
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

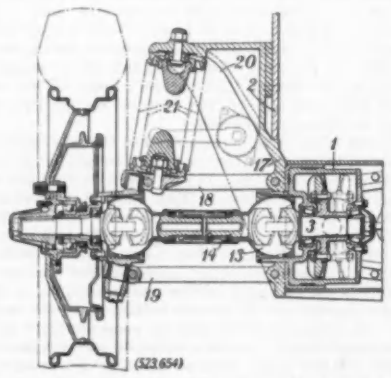
524,971. Dynamometer for Air-Cooled Engines. Heenan and Froude, Limited, of Worcester, and G. H. Walker, of Worcester. (5 *Figs.*) February 15, 1939.—The invention is a cooling system for use in conjunction with a dynamometer for testing air-cooled aircraft engines, and aims at increasing the cooling efficiency and preventing pollution of the test room atmosphere by exhaust fumes. The engine A under test is supported at one end of a streamlined nacelle B similar to that used in flight, and is directly connected to the dynamometer C and starting motor C^1. The nacelle is carried on a trolley, the supporting leg of which is streamlined and is used to house pipes, control levers and other connections from the engine. The extractor duct D is arranged beyond and co-axial with the nacelle and its mouth is flared, a throat being formed a short distance



from the mouth. From the throat, the duct enlarges gradually so that the velocity head of the air stream at the throat is converted into pressure head farther along the duct. The outlet of the duct to atmosphere is at the end of the gradual enlargement. The cooling air is supplied to the engine by a nozzle E at the end of a trunk, at the other end of which is a fan F. The drive to the dynamometer C passes through the trunk. The whole apparatus is housed in a test room and the ventilating air enters through a duct H at the opposite end of the room to the duct D. The air leaving the nozzle E passes over the engine and nacelle, mixing with the exhaust gases from the engine, and then passes to the extractor duct D. The ventilating air from the duct H also mixes with the air blast and exhaust gases and passes out with them through the extractor duct. The low pressure at the throat of the extractor duct thus aids both the cooling of the engine and the ventilation of the test room. (*Accepted August* 19, 1940.)

MOTOR VEHICLES.

523,654. Four-Wheel Drive Transmission. The Birmingham Small Arms Company, Limited, and H. Perkins, of Small Heath. (3 *Figs.*) October 17, 1938.—The transmission is designed for use in motor vehicles in



which both the front and the rear wheels are independently sprung and are both driven and steered. A box-shaped housing 1 is mounted on the inside of each chassis longitudinal and within it is a short axle 3 driven through bevel gears from a longitudinal propeller shaft connected to one of the output shafts of a central differential gear, which is common to the propeller shafts for the front and the rear wheels. A sleeve on the housing passes through a hole formed in the longitudinal 2 and houses a universal joint 13 connecting the axle 3 to a telescopic driving shaft 14, which is connected by another universal joint to the stub axle of the road wheel. On the outside of the chassis longitudinal is mounted a plate 17 having a central hole to permit of its assembly over the protruding outer end of the sleeve, and on it are formed upper and lower lugs for attachment of the upper and lower links 18, 19 of the independent suspension of the wheels. On the upper side of the plate is a bracket 20 forming the abutment for the upper ends of the suspension springs 21. (*Accepted* July 19, 1940.)

MISCELLANEOUS.

523,761. Gas Purifier. International Corporation, Limited, of London, and A. Ryner, of London. (3 *Figs.*) January 13, 1939.—The apparatus shown is designed to remove tar-fog, sulphuretted hydrogen, and carbon bisulphide from gases. The carbon bisulphide is removed by solution in pine oil or a similar water-immiscible solvent having low surface tension. Ferric oxide absorbs the sulphuretted hydrogen. The tar-fog itself is condensed by the action of the low temperature of the treatment liquid. The housing 1 has a gas inlet 2 and outlet 3, and contains three froth floors 4, 5, 6, arranged in parallel. Each floor consists of a number of troughs 7, the bottoms of which slope down from a central partition and are separated by gaps through which the gases flow upward. These gaps are surmounted by inverted U-shaped baffles 10, which direct the gases down through the copious froth which is formed on the liquid in the troughs. The gases next pass up between the baffles 10 and round inverted V-shaped baffles. Such a froth floor ensures a very intimate contact between gases and froth. The staggered arrangement of the floors gives a large floor area in a compact housing. The liquid in the troughs overflows through large elongated overflow ducts 13. Each row of ducts is sealed by a trough 14 (Fig. 2), the overflow edge of which is serrated. The liquid flows over this edge in fine streams forming a cur-

Fig.1.

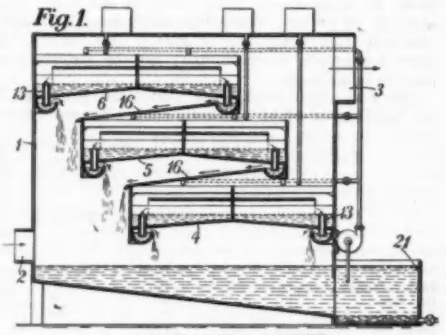
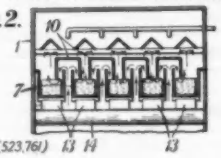


Fig.2.



tain of mist which makes intimate contact with the gases flowing through it. In the case of the two upper right-hand troughs in Fig. 1, the liquid does not immediately flow over their edges, but is first carried clear of the next floor below by a plate 16 with a serrated edge. The liquid is sprayed in above the floors 4, 5 and 6 by spray pipes. The liquid is finally collected in a sump with a sloping floor, whence it passes to a settling tank 21. The condensed tar floats upon the water and can be skimmed or decanted off. The solution of carbon bisulphide in oil settles to the bottom of the tank, where, however, the lowest layer of all is a precipitate of iron sulphide, together with ferric oxide, resulting from the action of the ferric oxide upon the sulphuretted hydrogen. These lower layers are run off through a cock. The carbon bisulphide is recovered by leading the solution into a water bath in which the bisulphide is distilled off, leaving the oil ready for re-use. The iron sulphide is exposed to the air and is converted back into iron oxide. The water, with unused oil and ferric oxide, is recirculated at a high rate. The purifier is also useful for the reconditioning of air circulated through a chamber containing artificial-silk spinning apparatus. The air is always charged with carbon bisulphide, which is removed by the purifier and subsequently recovered. The purified air, which is saturated with moisture as required, is then re-circulated through a closed circuit so preventing any escape of smell. (*Accepted July* 22, 1940.)